CHEMICAL & METALLURGICAL ENGINEERING

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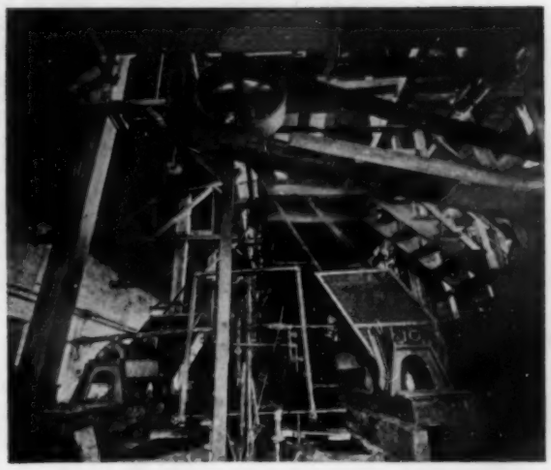

LUBRICATING THE WHEELS OF INDUSTRY

In a chemical plant like this one, the chemical engineer and production man have no end of problems—not the least important of which have to do with proper lubrication. Power-driven process equipment of all sorts—operating continuously, bearings difficult to reach and exposed to corrosive atmospheres. No wonder lubrication is sometimes neglected, yet when it is, maintenance costs are sure to rise. What's to be done about it?

In the duPont company's industrial engineering department is a well qualified and long experienced lubrication engineer working closely with a well-known power-transmission specialist in the solution of lubrication problems of every sort met in chemical plants. These men, at one request, have agreed to share some of their knowledge and experience with **Chem. & Met.** readers in two important articles—the first of which appears in this issue.—Editors.

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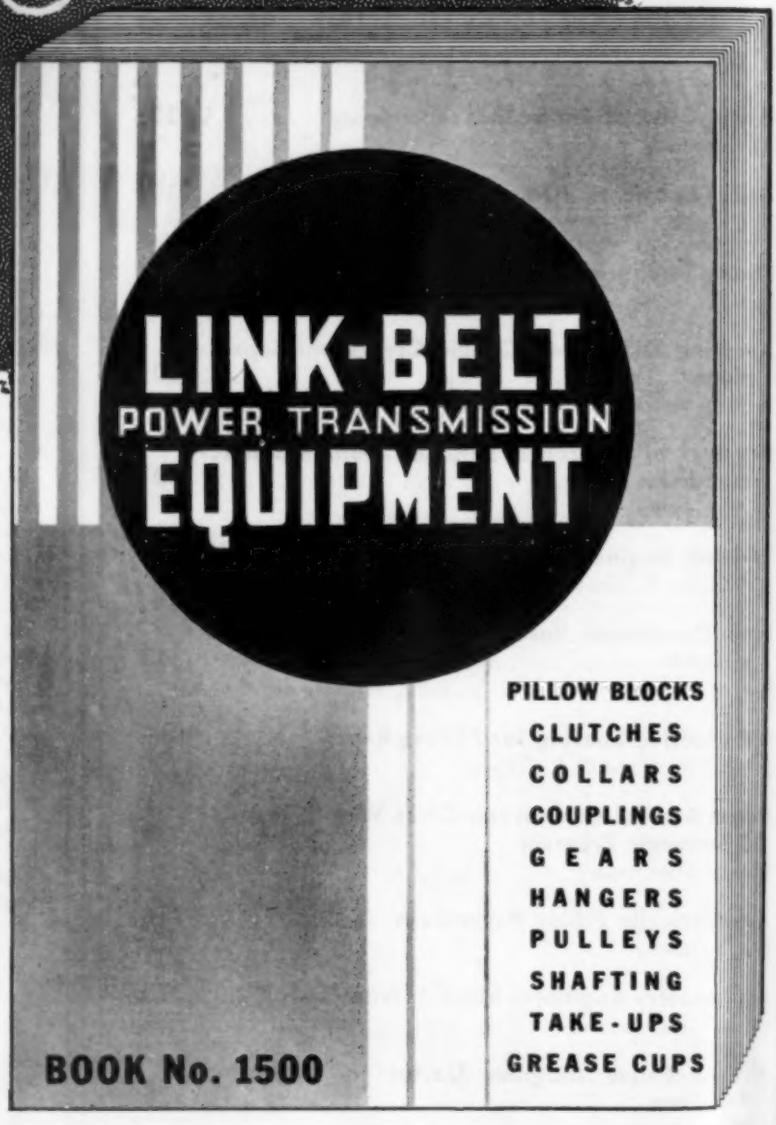

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S. D. KIRKPATRICK, Editor

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JUNE, 1936

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POWER ALCOHOL TRANSCENDS TECHNOLOGY

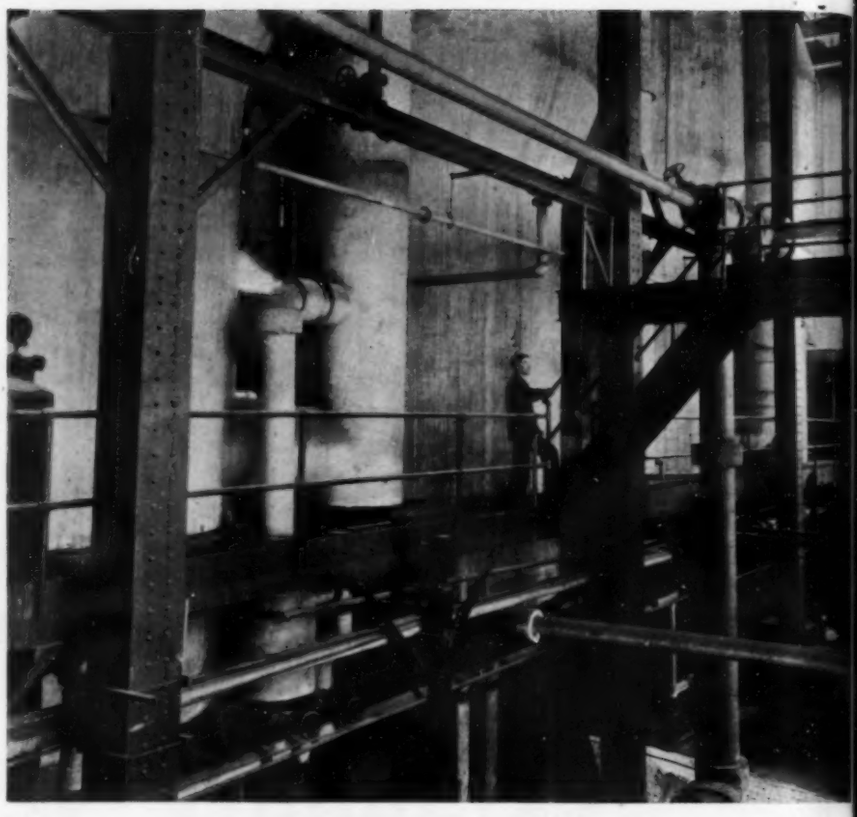
THERE need have been no power alcohol controversy. In fact, most of the technical issues that have been raised between the agricultural chemists and the oil technologists have merely fanned a flame that would either have consumed itself or would have inevitably spread on its own account. There is little or nothing essentially new about alcohol motor fuels. Claims and counter-claims notwithstanding, the low percentage blends under present consideration can probably be used interchangeably with gasoline without any very noticeable effect on engine performance. So much for technology; economics is another story.

But just as the technical phases of this question have been needlessly complicated, the economic aspects have been over-simplified. One side has tried to rule out power alcohol simply on a cost basis while the other has argued that its alleged superiority would more than offset its dearness. Both sides overlooked the fact that there may be other economic conditions than costs that can control in this situation. We have a farm problem that has national and international ramifications. Conceivably a condition that makes it economical for Great Britain, with her vast holdings of petroleum resources, to use an alcohol blend might some day obtain in this country, despite our cheap but not inexhaustible supply of crude oil. Power alcohol, it seems to us, is not so much a problem of technology and economics as it is of agricultural distress and farm relief.

So, we repeat, there should have been no controversy—least of all among technical men. Some one of the oil companies could well have afforded to sponsor an experimental program such as the one in Kansas which is now being started with the backing of the Chemical Foundation. If the oil industry recognizes its stewardship and responsibility to serve the motor fuel needs of the public, it should not turn its back on what appears to be the evident desires of a fair proportion of the agricultural population. For good business reasons, it would have been better to have had a hand in guiding and controlling the development rather than opposing it with a barrage of controversy or by attempting to suppress its open discussion before our technical societies. It is always poor strategy to oppose free and open debate or experimentation which has for its purpose a sincere attempt to solve a national problem.

From a strictly chemical engineering viewpoint, it is a bit unfortunate that the power alcohol problem is not one that can be readily solved by purely technical and economic reasoning. It has social and political implications that cannot be easily evaluated, yet nevertheless are controlling factors today in many countries of the world. We shall be fortunate in the United States if we can avoid subsidies, tax exemptions or other forms of governmental aid such as are so common abroad. Yet if they must come and are honestly administered it is possible that they will serve as a better means of farm relief than the crop restriction payments or subterfuge schemes for preventing soil erosion. At least the farmer will be paid for *using* rather than *wasting* his surplus crops.

FROM AN EDITORIAL VIEWPOINT



» To a Builder of Better Literature

MERELY to add to the multiplicity of medals and awards for achievement among chemists and chemical engineers is undesirable unless there is a constructive and useful purpose to be served. Such is the case, however, with the William H. Walker Award, recently established by the American Institute of Chemical Engineers "to stimulate interest in shaping a better chemical engineering literature." It does honor to the name of one who helped to lay the very foundations on which our modern chemical engineering literature has been built. And it is particularly appropriate that the first winner of the award should be a brilliant young man whose outstanding work has been referred to oftener in the last three volumes of the Institute's *Transactions* than that of any other living chemical engineer. Dr. Allan P. Colburn of the duPont company is well deserving of the praise of the profession and it is hoped that this award will stimulate and encourage him in the valiant fight he is making at Saranac for the recovery of his health.

» Eyes, But They See Not . . . .

FORTY THOUSAND glass eyes are imported each year. They are works of art, and sometimes hard to distinguish from the real thing. The only difficulty with them, unfortunately, is that the wearer cannot see through them.

We have just finished reading several pieces of pertinently useful literature recently issued by the National Society for the Prevention of Blindness of New York. In an emphatic and positive way "Eye Conservation" is discussed in a number of its different phases. Covered are eye accidents, eye protection and the use of goggles, eye examination, and sight-saving cooperation between physician and safety engineer. By all means write for this literature. It is "required reading."

But that is not the point of this editorial. What one *reads* is one thing. What one *does* about it is another. Do we need the equivalent of a "And Sudden Death" in our industrial magazines to stir us to coordinated action on eye conservation?

It is not our purpose to cram this little message with lurid facts or harsh statistics on the subject. Plenty of this type of reading matter is available from more authoritative sources. Every executive, plant manager, and safety engineer owes it to himself, to his company, and most important to his workers to keep informed and up-to-the-minute on all eye conservation data and practices.

What we yearn for, and what we would be happy to participate in, is a concentrated and continuous drive for *real* eye conservation practice. A drive that will not only insure the proper use of goggles in all industrial plants, large or small, for every eye hazardous operation—but that will go beyond the accident factor to such practices as regular eye examinations for both plant and office workers—to proper plant painting and lighting for the best possible working conditions at all times.

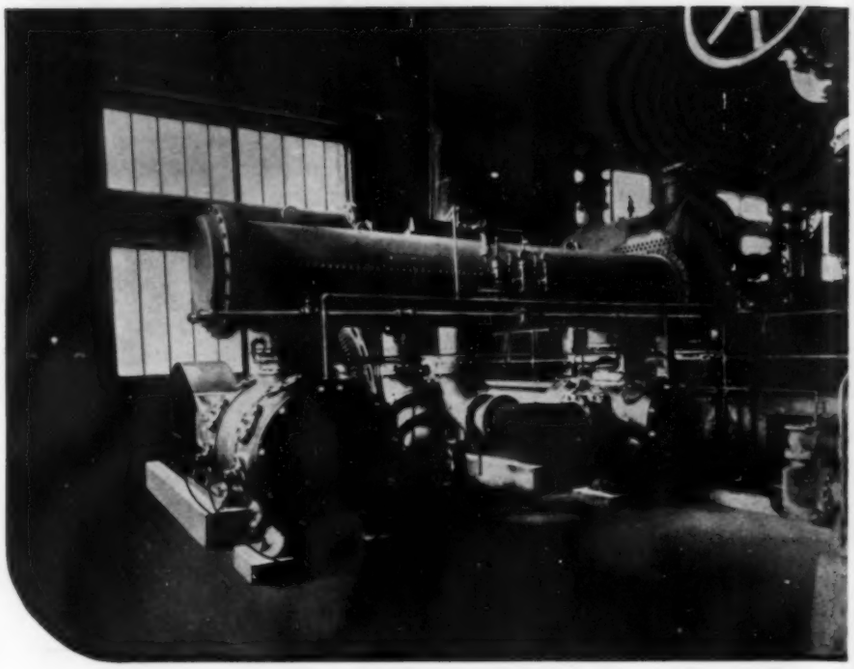
Nor will a *real* eye conservation plan end here. A thorough, intensive plan will go much farther. There will come a day—yes, and it is not far away—when management will not only protect the workers' eyes—not only examine and test the workers' eyes at regular intervals—not only provide ideal lighting and working conditions—but will go on and carry all these progressive practices to their logical conclusion—compulsory eye conservation. What is more logical than this? The average worker spends far more of his active day in the plant than in any other one place. It is in the plant where his eyes are put to their maximum of use. And forgetting sociological or humanitarian reasons purposely for a moment, his working efficiency—which is an integral part of the plant's production efficiency—is directly dependent on his eye health.

Here is an important and worthwhile job for management. The profits and prosperity of plant and worker are mutual in this. Recognition and rewards have already come to such companies as Lever Brothers, Union Carbide, Diamond Crystal Salt, duPont, Canadian Industries, Ltd., for the outstanding eye conservation work they have done. Proper glasses on the worker will put rose-colored glasses on his bosses.

»Speed vs. Safety in Experimentation

CHEMICAL engineers are too often shocked and grieved to learn of the death of another professional associate "killed in action." We refer, of course, to those injured or killed in the course of engineering and laboratory experimentation. The exigencies of experimental work involve certain inevitable hazards. But a hazard recognized is one more than half eliminated. Only when too great familiarity with experimental uncertainties induces carelessness is there unwarranted risk or excessive danger.

The pressure for speed in experimentation is occasionally responsible for neglect of obvious precautions. However, excessive zeal on the part of the experimenter is more often the fundamental cause than any pressure from executives. In fact, it would probably be very difficult to find any case in which the executives supervising research and development work of chemical engineers are not more careful than the workers themselves. Yet, with the frequently recurring cases of accidental death among professional men in these fields, there seems to be warrant for saying that executives have not yet gone far enough. A timely word of warning to their zealous investigators is occasionally needed.



Chicago Pneumatic air compressor driven by synchronous motor

First of two articles from outstanding authorities dealing with a subject too often neglected by chemical engineers and plant management. In this series the authors were asked to give CHEM. & MET. readers the same sort of advice and instructions as are normally given to operating men in duPont plants.—Editor.

BETTER LUBRICATION MEANS LOWER MAINTENANCE

By LAWRENCE G. BENTON and WILLIAM STANIAR

Respectively, Lubrication Engineer and Mechanical Power Engineer
E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

LUBRICATION of mechanical equipment in chemical plants involves both chemical and mechanical problems not present in other lines of manufacture. It has been possible to meet them only by the use of more adaptable lubricants, and better methods of application. Irrespective, however, of the possibility of obtaining proper lubrication, excessive maintenance and power consumption are frequently evident, since the economic importance of correct lubrication is quite often overlooked by chemical engineers and plant executives.

Lubrication problems in the chemical industry can in general, be classified as follows: those pertaining to the generation of power, compression of air or other gases, refrigeration, mechanical transmission of power and manufacturing or processing equipment. Sub-dividing these general problems: Power production involves the use of turbines, steam engines, gas engines and diesel engines. Power-driven equipment consists of compressors, vacuum pumps and refrigerating machines. Auxiliary equipment consist of feedwater pumps, circulating, condenser, dry vacuum and works supply pumps. In the operation of engine-driven units, there is also need of eliminating cylinder oil from boiler feedwater.

Lubrication of power-house equipment presents the problem of selecting lubricants adaptable to operating conditions. Outside the power house, mechanical transmission of power requires lubrication of bearings, open and reduction gear units, clutches, chains, loose pulleys and wire rope. Manufacturing equipment calls for the lubrication of bearings, gearing, stuffing boxes and all moving parts.

Turbines—Turbo-generators due to their compactness and resulting economy of floor space, steam flexibility and efficiency of operation have taken the lead in prime movers in industrial plants. Mechanically, the lubrication of steam turbines is not a difficult problem. The oiling system comprises a rotary gear pump driven from the governor shaft. The function of this pump is to circulate oil through the bearings under pressure, and to operate the governor.

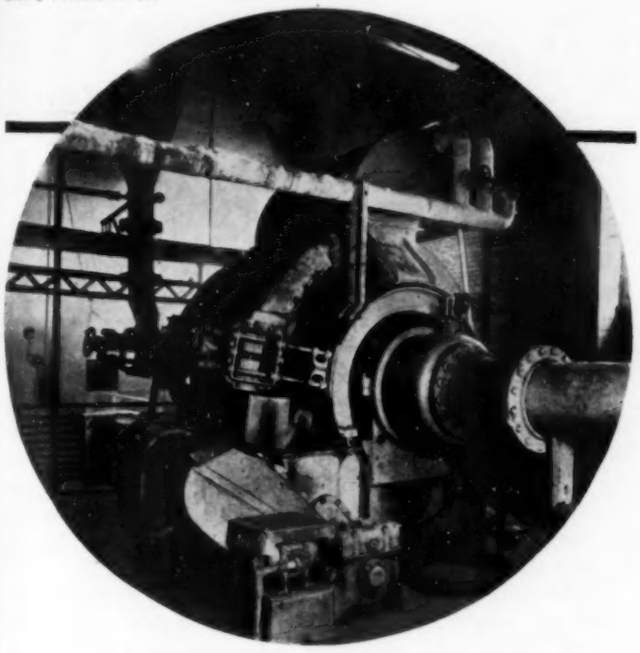
Oil Purification—Purification of turbine oils is an extremely important factor in continuous operation and maintenance. Fortunately, this matter is being rightfully given more consideration by plant engineers and executives than in the past. Standard equipment on certain types of turbines consists of an oil cooler and filter. In addition the use of a centrifuge, which may be operated as a unit with the turbine or by the batch system, is advocated. Another desirable method of purification is accomplished by continuous washing of the oil with condensate, followed by centrifuging. It is not difficult to see that by the correct method of treatment, such factors as oxidation, acidity and sludge formation are definitely under control.

Employment of both centrifuge and filter is justified by the physical facts inherent in these pieces of equip-

ment. Briefly, a centrifuge will separate water and other foreign material carried in suspension, due to the difference in gravity. It will not remove foreign matter as thoroughly as a filter, where the particles are of lower specific gravity than the oil. The reason for advocating both systems is, therefore, apparent. This paper thus far has dwelt upon the mechanics of turbine lubrication. The predominating trouble with turbine oil is chemical. Resistance to oxidation, demulsibility and acidity are the most important factors to be considered. In the production of turbine oils, therefore, the refiner is guided by two requisites; viz., viscosity and chemical stability.

Viscosity—An oil of 145-155 seconds at 100 deg. F. as taken with the Saybolt Universal Viscometer (S.U.V.) is the accepted viscosity for turbines designed for pressure oiling systems. Turbines for driving blowers, feedwater pumps and similar equipment employing ring oil-

Illustrations courtesy of Socony-Vacuum Oil Co.



Vacuum filter drying salt

ing bearings very often operate at temperatures above 160 deg. F. Where these conditions exist a steam cylinder oil preferably a "bright stock" of about 150 sec. S.U.V. at 210 deg. F. is employed. If an oil of this character is used, inspection of the rings is essential in starting, as the high viscosity of the oil at low temperature may not allow the rings to start.

In establishing an oil of about 150 sec. S.U.V. at 100 deg. F. for force feed turbine lubrication, it has been found that more viscous oils tend to raise bearing temperatures. This is probably due to increased frictional drag of the oil film. Oils of lower viscosity than 145 sec. may be too close to boundary lubrication. When it is considered that turbine spindles operate continuously at peripheral velocities exceeding 5,000 f.p.m., it is not difficult to see that an oil of high viscosity cannot follow the spindle. The result is that metallic contact may occur with disastrous results. Again, due to surface tension, suspended matter and water are more readily carried in viscous than in non-viscous oils.

Stability—With modern methods of refining, the geographical source of the crude oil is not as important a factor in the production of lubricating oils as it was in the past. The fact still remains, however, that some crudes produce better lubricants than others. It is also true that not all crudes are suitable for the manufacture of lubricating oils. Refiners have spent large sums in research work and testing equipment in order to increase the lubricating value of their products. These values have been found to lie in improved methods of treatment and refining. "Chemical stability," as applied to petroleum lubricating oils, has resulted from the application of solvent extraction or hydrogenation treatment to remove certain undesirable hydrocarbons, that in the past have been the cause of failure, principally through oxidation.

The plant manager may, therefore feel assured that lubricating oils now purchased are of greater value than existed a few years ago. In a subsequent article an attempt will be made to explain how the user may capitalize on this increased value.

Demulsibility—Turbine oils must be capable of separating readily from water. If they do not, emulsions are formed. Oils possessing full demulsibility values indicate a high degree of refinement. Determinations of demulsibility values are made by two established methods, viz., Herschel and S. E. number (steam emulsion). An oil rated as 1620 Herschel or 60 S. E. denotes full demulsibility.

The Herschel reading is obtained by agitating 53 c.c. of distilled water and 27 c.c. of oil at 130 deg. F. If complete separation occurs in 60 seconds, then 60 x 27 = 1620.

The S. E. reading is obtained by placing 20 c.c. of oil in a tube and agitating with steam until 40 c.c. is obtained. Upon releasing the steam the tube is placed in an emulsifying bath. The seconds of time required for complete separation is reported as S. E. number. Method, 320.6 A.S.T.M. D 157-28.

Suspended matter in water and excessive temperature are the chief contributing factors toward turbine oil failure. The chemist can readily appreciate that water (condensate) in contact with cast iron under temperature produces a base for iron soaps. Oil at high temperature tends to oxidize. Iron soaps and oxidized oil produce what is commonly called sludge. Care should be taken to prevent entry of water into the system. If water does form, it should be drained at regular intervals, provided purifying equipment is not available.

Another contributing factor in connection with turbine oil failure is through the medium of boiler compounds. A high pH value in the condensate is a contributing factor in the formation of metallic soaps. These soaps result in poor demulsibility, and possibly excessive foaming.

Acidity—Mineral acids are present in all petroleum lubricating oils. Their presence above a certain point tends to pit or etch metallic surfaces. They may be removed or reduced by careful refining to such a degree that no reaction takes place in service.

Acidity develops, however, when the oil is subjected to high operating temperatures. If the oil temperature leaving the bearing does not exceed 130 deg. F., and

water is not allowed to accumulate, both acidity and sludge formation will be maintained at low limits. But in the absence of purifying and cooling equipment, especially if neglected, it may become necessary to change oil after 3 to 6 month periods of operation.

The measure of acidity is the "Neutralization number" which is the weight in milligrams of potassium hydroxide required to neutralize one gram of the oil. This determination is made by A.S.T.M. Method D188-27T. The neutralization number of new turbine oil should not exceed 0.05 mg. KOH per gram.

Works engineers of the duPont company are requested to check acidity at bi-monthly periods. The oil is allowed to reach 0.85 mg. KOH per gram before ordering a change to new oil. As a result of careful supervision as well as centrifuging, filtering and cooling, one of our plants has not changed oil in 3 years, and still the acidity does not exceed 0.35. Make up oil has of course been added during this period.

Oxidation by Sligh Method—This method of measuring the resistance to oxidation of mineral oils was developed by the U. S. Bureau of Standards. Primarily the test is for the examination of lubricating oils used in internal combustion and explosive type engines.

It is also used to some extent in connection with turbine oils, and is one means of evaluating the degree of refinement. An oil of low oxidation number has very slight tendency to form sludge, the reason being that an oil to possess this value must be refined to such a degree that certain undesirable hydrocarbons and other impurities have been removed.

Resistance to oxidation by the Sligh method is determined by weighing 10 grams of oil into a standard Sligh flask and heating to 200 deg. C. for 2 hours and 30 minutes in the presence of oxygen. The sludge or precipitate is weighed and reported as parts per ten thousand. This figure represents the Sligh number.

Indiana Oxidation Test—This test consists essentially in passing 10 liters of air per hour through a glass tube containing 300 c.c. of test oil, maintained at 175.5 deg. C. Then 25 c.c. of oil is removed periodically, diluted with precipitation naphtha, and the solution filtered through a Gooch crucible. Any asphaltic materials that have been formed by oxidation are retained on the filter and weighed. The oxidation resistances of various oils are compared by the respective times in hours required for the oil to form 10 mg. and 100 mg. of sludge per 10-gram oil sample.

Steam Engine Lubrication

Selecting the correct oil for service for cylinder lubrication is governed principally by two factors, viz. steam pressure (temperature) and its condition. The latter factor relates to the degree of moisture carried in suspension. It is appreciated that all steam is wet steam unless it is superheated. It is arbitrarily assumed, however, that steam having a moisture content of 3 per cent or above is wet steam.

Cylinder oils are residual oils and are known to the refiner as "cylinder stocks." They are the most viscous lubricating products obtained from petroleum. The viscosity range is from about 140 to 320 sec. S.U.V. at 210 deg. F., while the flash points (open cup) are from 520 deg. to 630 deg. F.

To apply these oils directly as steam cylinder lubricants without further treatment is not altogether successful or economical. To make them adaptable to this service, they are compounded with fatty oils, principally tallow, lard, neatsfoot or degras in percentages from 4 to 15 by volume. Tallow oil is most commonly used, and when blended with degras is known as "prepared degras." Probably 80 per cent of the cylinder oil sold is compounded with tallow oil.

The reason for compounding is apparent, when the moisture content of saturated steam, coupled with condensation on the cylinder walls is considered. Mineral oil alone does not emulsify and will not therefore cling to the wet cylinder walls, and valve faces. Fatty oils emulsify readily and possess better wetting properties, hence by compounding with a mineral oil, the advantages of both are utilized.

An unfiltered cylinder stock of 145-160 sec. S.U.V. at 210 deg. F. is utilized as a base in the majority of cases, where steam pressures vary from 100 to 165 lb.

Steam pumps operating at piston speeds up to 50 f.p.m. and engines of low piston speed, will be more effectively lubricated with a cylinder oil of about 125-130 sec. S.U.V. at 210 deg. F. Cylinders supplied with steam under 100 lb. gage and containing a high moisture content will be more effectively lubricated by compounding with 10 to 12 per cent of fatty oil. Conventional cylinder oils contain 5 to 6 per cent fatty oil.

Boiler feed water of high pH value is very destructive to cylinder lubrication as the alkaline content saponifies the fatty acids thereby destroying the effectiveness of the oil, and leaving the rubbing surfaces dry. In some instances of this nature the situation may be relieved by compounding with from 5 to 10 per cent of degras —since the latter is about 60 per cent saponifiable.

Lubrication of enclosed crank-case steam engines presents an aggravated condition when water enters the system. The only source of admission is through the piston rod packing. To prevent entrance of water,

Vacuum filter pumps in a cement plant

packed baffle plates are constructed between the cylinder head and cross head. On horizontal engines, this baffle is very effective, but on the vertical type it is very difficult to prevent entrance of some water to the crank case. Thus the operating conditions are quite similar to those prevailing in turbine lubrication.

A condition arises, however, in crank-case lubrication that does not exist with turbine or motor driven crank-case equipment. Compounded cylinder oils carried into the crank case by the piston rods form soaps due to the fatty oils used in compounding. There is only one way to overcome this condition and that is by using a straight mineral oil in the steam cylinders. This method is, however, a compromise, as inferior cylinder lubrication results.

Selection of a crank-case oil for steam driven equipment calls for one having full demulsibility (1620 Herschel) if excessive sludging is to be avoided. A pale oil of 180 to 300 sec. viscosity at 100 deg. F. is used in this service.

Accumulation of water in the crank case should be prevented by trapping. Oil change cycles depend upon the condition of the oil after a given period of operation. Oil drained from the crank case, if stored in a clean container, will in time separate into distinctive lines of demarcation. The top layer may be syphoned off, filtered and put back into service. The lubricating value of the oil has not been injured, but merely contaminated. It follows, therefore, that removal of foreign matter restores the oil to its former value.

Ice Machine Lubrication

Cylinder lubrication of ice machines calls for an oil of low pour point. If this feature is neglected and an oil of high pour point is used, an accumulation of oil and wax will build up in the expansion coils. When this occurs, the efficiency of the compressor is lowered, depending upon the thickness of the deposit. Should this condition occur, it will be necessary to steam out the coils.

In crank-case type compressors, the oil must not only lubricate the cylinders, but bearings as well. Where ammonia is used as a refrigerant, the oil should be of 0 deg. F. pour point or below. The viscosity may be from 200 to 300 sec. S.U.V. at 100 deg. F. The carbon content (Conradson method) should not exceed 0.03 per cent.

For extremely low temperatures using refrigerants other than ammonia, it is necessary to use a pale oil of —35 to —40 deg. F. pour point. Oils of this character, however, generally run from 120 to 150 sec. viscosity S. U. V. at 100 deg. F. No bearing trouble will be experienced in operating with an oil of this viscosity, as applied to the smaller type of vertical compressors using trunk pistons.

Superheated Steam—It is generally conceded that the more viscous high-flash point oils are essential to proper cylinder lubrication employing superheated steam. This matter is disputed by some engineers, however, who point out that in practice a cylinder oil of 530 deg. F. flash and 600 deg. F. fire compounded with 5 per cent lard oil or tallow oil has provided good lubrication with steam at 450 lb. gage pressure, superheated to 720 deg. F.

A few years ago a test was conducted in Germany on a compound engine with steam superheated to 800 deg. F. A cylinder stock of 680 deg. F. fire test and 220 sec. S.U.V. was first tried. This test was followed with a cylinder oil of 600 deg. F. fire test, 145 sec. S.U.V. at 210 deg. F. compounded with 5 per cent tallow oil. The results attained with the lower viscosity compounded oil were superior to those attained with the more viscous product not compounded.

The duPont company, at one of its plants, operates engines with steam at 435 lb. gage pressure, superheated to 720 deg. F. The oil used is a bright stock (filtered cylinder oil) of 610 deg. F. fire test, 150 sec. S.U.V. at 210 deg. F. compounded with a duPont product. This oil has been in service about two years and has provided perfect lubrication to cylinders, valves and metallic rod packing. Another feature in its favor is that less trouble is experienced in removing traces of oil from the condensate. This factor is important where the condensate is used for process work, boiler feed water or both.

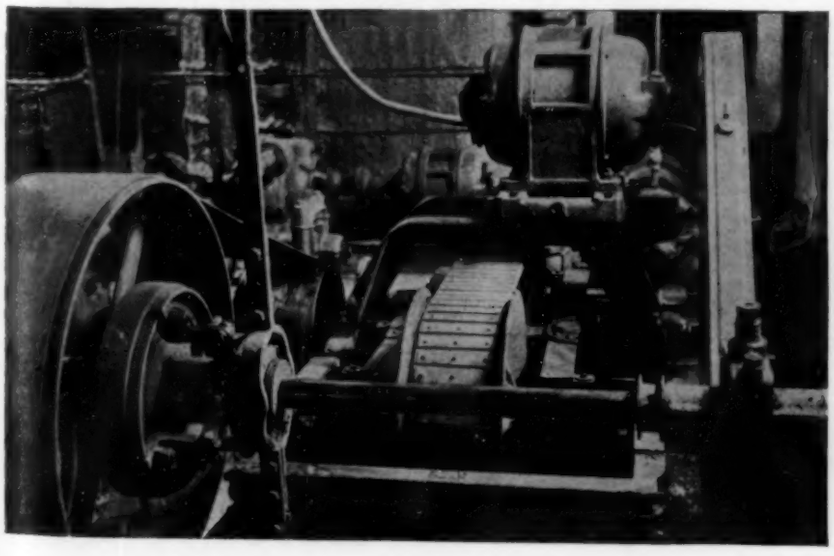
One of the principal troubles arising through the use of superheated steam is the tendency of the oil to form coke on piston heads, valves and in the packing. Our experience has been that if air is not allowed to enter the cylinder after shutting down no coking of the oil will occur.

We have a rule that no cylinder head shall be removed nor cylinder cocks opened on an engine running under superheated steam until at least three hours after closing the throttle.

To avoid this delay period, and provide against accidental or careless admission of air to the cylinders after shutting down a one-inch connection under the throttle can be made to a line carrying saturated steam. By admitting saturated steam, and keeping the engine turning over a few minutes, air will be excluded and the temperature of the cylinder brought below the coking point of the oil.

Oil application is made by a force feed lubricator. One lead is carried

Variable speed transmission in a board mill



direct to the cylinder, and introduced at the central vertical axis, thereby allowing the piston to act as a wiper. A second lead is connected to a quill above the throttle in order to atomize the oil for lubrication of the valves.

Air Cylinder Lubrication

The main factors to be considered in the selection of an oil for the lubrication of compressed air cylinders are; the temperature of the compressed air, and the area in square feet rubbed over by the piston per minute.

The table below, from Ingersoll-Rand, gives the theoretical cylinder temperature at end of piston stroke on adiabatic compression.

Air Compressed to	Final temperature (Deg. Fahrenheit) Single stage	Two stage
40 lb. gage	302	—
50 lb. gage	339	188
60 lb. gage	375	203
70 lb. gage	405	214
80 lb. gage	432	224
90 lb. gage	459	234
100 lb. gage	486	243
110 lb. gage	507	250
120 lb. gage	529	257
130 lb. gage	550	265

Rate of Feed—The rate of oil feed to an air cylinder is in many cases one of judgment on the part of the engine room crew. It is almost invariably the practice to over-lubricate in order to be on the safe side. We have found that the following rule provides an adequate supply of oil under conventional operating conditions: The square feet swept over by the piston per minute divided by the constant 465 will give the drops per minute required.

Aside from rules and judgment as to the correct amount of oil feed, the most satisfactory method is to remove the valves and examine the cylinder walls. If by appearance or by feeling dryness is indicated, the feed should be increased. If on the other hand an excess is present, then the cylinder is over lubricated, and the feed should be reduced. These observations should be taken weekly until the correct determination is made, and then checked at intervals of two or three months. This method not only reaches the objective but at the same time allows an opportunity for valve inspection and possible cleaning.

It is conventional practice to select an oil for air compressor service from a standpoint of flash or fire test. In our experience an oil should be chosen of the correct viscosity and carbon content. If the viscosity is high enough and the carbon content low, the other physical constants naturally follow. For the average two-stage compressor employing gage pressure from 60-80 lb., a pale oil of 300-320 sec. S.U.V. at 100 deg. F. and a carbon content (Conradson) of 0.04 per cent maximum will provide safe and economical lubrication.

In connection with the subject of air compression, it may be well to point out that many engineers advocate the employment of two-stage compressors for pressures up to and above 60 lb. gage.

Air Intake—One of the most important factors in the operation of air compressors is to provide for the admission of clean air. It is astonishing to note how many plants operate with little or no provision against the entrance of foreign matter into the cylinders. Samples of so called carbon deposits taken from valves and piston heads reveal upon analysis a content as high as 70 per cent by weight of silicates, coal ash and other abrasive material.

Intake air cleaners are available from several reputable manufacturers. If, however, it is not considered necessary nor advisable to install air cleaners, it is recommended that the air intake line be extended above the eaves of the building.

Air Receiver Fires—Air compressor fires or explosions are caused primarily by the accumulation of oil and carbon in the discharge lines and receiver. When the air in the lines attains a sufficiently high temperature, spontaneous ignition occurs.

Over lubrication is a contributing cause, by allowing surplus oil to accumulate on the walls of the discharge line. Operating under temperatures shown in the table, the oil is slowly oxidized, resulting in the deposit of heavy residues, and small particles of carbon (petroleum coke). To prevent the depositing of this material, the oil feed should be regulated to the correct amount. As an assurance against fires, water or steam may be injected into the line as close to the compressor cylinder as possible. If water is used a pump may be required, provided the water line pressure is below the air line pressure. A pump lubricator driven from the compressor and operated at full stroke will provide sufficient water. If steam is used, cracking a $\frac{1}{4}$ in. valve will accomplish the purpose.

If the air lines are coated with oil deposits, they may be removed by injecting a potash solution using an ounce of lye to a gallon of water. This solution should be fed at the rate of about 10 ozs. per hour, bi-monthly.

One objection to the use of potash is that it may affect some process, where air is used for agitation. Accordingly this matter should first be referred to the chemical engineer or the works chemist.

For removing deposits in the air cylinders, piston rings and valves, it is recommended to use one pint of soft-soap dissolved in two gallons of water. Feed this solution to the cylinders bi-weekly for two hours at a rate equal to 10 times the quantity of oil feed. Oil is not to be used during this period but must be resumed immediately after shutting off the soap supply. Soft soap being a potash soap may also affect some process work, and its use should be referred to the chemist or engineer.

Based on the possible objections to chemical treatment, some engineers prefer the use of wet steam in the air discharge lines. The extra amount of moisture in the air as a result of steaming apparently condenses out to the saturation point of the air at the pressure carried.

Steaming is suggested especially on days when the temperature is high and the humidity low. At such periods cooling water in the cylinder jackets is at its maximum, a contributing factor to high discharge temperatures, when compressors are driven to or above rating.

It is not necessary to use steam or water in air lines during the winter months in the northern states.

Probably the most approved method of controlling air temperature in the discharge lines, is the use of "after coolers." This equipment is in reality a heat exchanger, supplied by the compressor manufacturers.

Strong Sulphuric Acid From Wet Sulphur Dioxide

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RECOVERY of sulphuric acid from wet sulphurous gases can be effected by a new process that has been developed in the laboratories of the Metallgesellschaft A. G., of Frankfurt a. Main, Germany, and commercially introduced by this concern under the name of "Wet Catalysis." This process differs fundamentally from the well-known sulphuric acid contact process in that the SO_3 gases are not absorbed in the usual manner by concentrated sulphuric acid, but are, together with the water vapor, subjected to fractional condensation. This results in complete condensation of the SO_3 but only partial condensation of the water vapor. The temperature determines the quantity of the water vapor condensed, thus directly affecting the strength of the acid produced. Simple temperature regulation makes it possible to vary the concentration of the acid within certain limits up to 88 to 90 per cent H_2SO_4.

Gases especially suitable for this process are those that originally or through reaction contain water vapor. A gas of the latter type is hydrogen sulphide. For example, in coke oven plants eliminating ammonia from the gas by the indirect method, 30 to 40 per cent of the sulphur passes into the ammonia liquor. In the ammonia stills the sulphur compounds are volatilized along with the ammonia and separated from the latter material in the saturator where the ammonia is converted into ammonium sulphate by reaction with sulphuric acid. The hydrogen sulphide escapes as waste gas from the saturator, together with carbon dioxide, oxygen, nitrogen and small quantities of organic materials. Without some form of recovery this waste gas is a nuisance, but by means of the new process it can be converted into an asset.

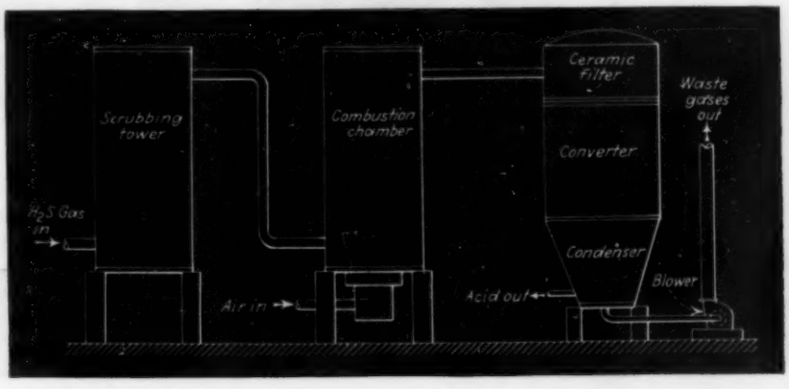
The waste gases leave the saturator at a temperature of about 100 deg. C., saturated with water, and are usually cooled in a countercurrent scrubber irrigated with water. As the water leaves hot, no appreciable quantity of hydrogen sulphide is removed in solution. From the scrubber the gas passes to a combustion chamber where it is burned with excess air according to the reaction: $H_2S + 3O = SO_2 + H_2O$. With normal H_2S content of the gases, namely, 20 to 30 per cent by volume, combustion chamber temperatures range from 750 to 800 deg. C. With gas as poor as 10 per cent H_2S, combustion can be maintained through the use of an ignition arch or a checker brick lining in the combustion chamber to catalyze the burning.

The molecule of water vapor formed by the reaction would be sufficient to complicate considerably the treatment of such gases in the ordinary contact plant. In such cases it is customary to cool the gases leaving the combustion chamber to condense the water vapor and then to reheat again to the necessary temperature for the converters. This is a rather involved procedure and adds to the difficulties of operation.

In the wet catalysis process the gases are led without drying directly from the combustion chamber to the converter and from there directly into the condenser. In larger plants it is possible, by means of a waste heat boiler, to utilize the excess heat in the gases leaving the combustion chamber. It is obvious that the wet catalysis process offers a very simple method of operation, since in this process the cooling and reheating of the gases as well as the usual absorbing towers and pumps are omitted.

The conversion of SO_2 into SO_3 in the presence of a catalyst is an exothermic reaction. The heat set free is used in the standard contact process to preheat the SO_2 gases in the heat exchanger. This procedure is difficult and requires exact supervision and temperature control. Wet catalysis offers a simpler treatment. It is not necessary to preheat the gases since they possess sufficient heat when leaving the combustion chamber before entering the converter. It is only necessary to remove the excess heat in the converter by means of cooling. This is accomplished by equipping the converter with an air-cooled jacket. The quantity of cooling air can be varied easily and by this means the temperature in the converter is regulated. Fluctuations in the SO_2 content of the gases, even down to 2 per cent by volume, cause no particular difficulties.

Fig. 1—Diagrammatic arrangement of equipment for producing sulphuric acid by wet catalysis



The reaction of the gases in the converter is not affected by their moisture content, provided a suitable catalyst is selected. Vanadium mass has been shown to be excellent and conversions up to 98 per cent have been obtained in commercial operation.

A wet catalysis plant is shown schematically in Fig. 1. It consists of the following: (1) A scrubber tower to cool and wash the gases. If the gases are clean and available at a temperature of approximately 35 deg. C., this tower may be omitted; (2) a combustion chamber where the hydrogen sulphide is burned to sulphur dioxide in the presence of excess air; (3) a filter serving as a special protection for the catalyst. This may be omitted when clean gases are available; (4) the converter for converting the SO_2 gas to SO_3; (5) a condenser where the SO_3 is condensed with the necessary quantity of water to form sulphuric acid; (6) a blower; and (7) the waste gas flue.

The condenser is of special interest. Every sulphuric acid man knows that the tendency of SO_3 is to form fumes or mist when cooled and that it is very difficult to absorb and condense such mist. As is indicated in U. S. Patent 2,017,676, it has been possible to develop a method to avoid this mist formation and to obtain practically a quantitative condensation of SO_3.

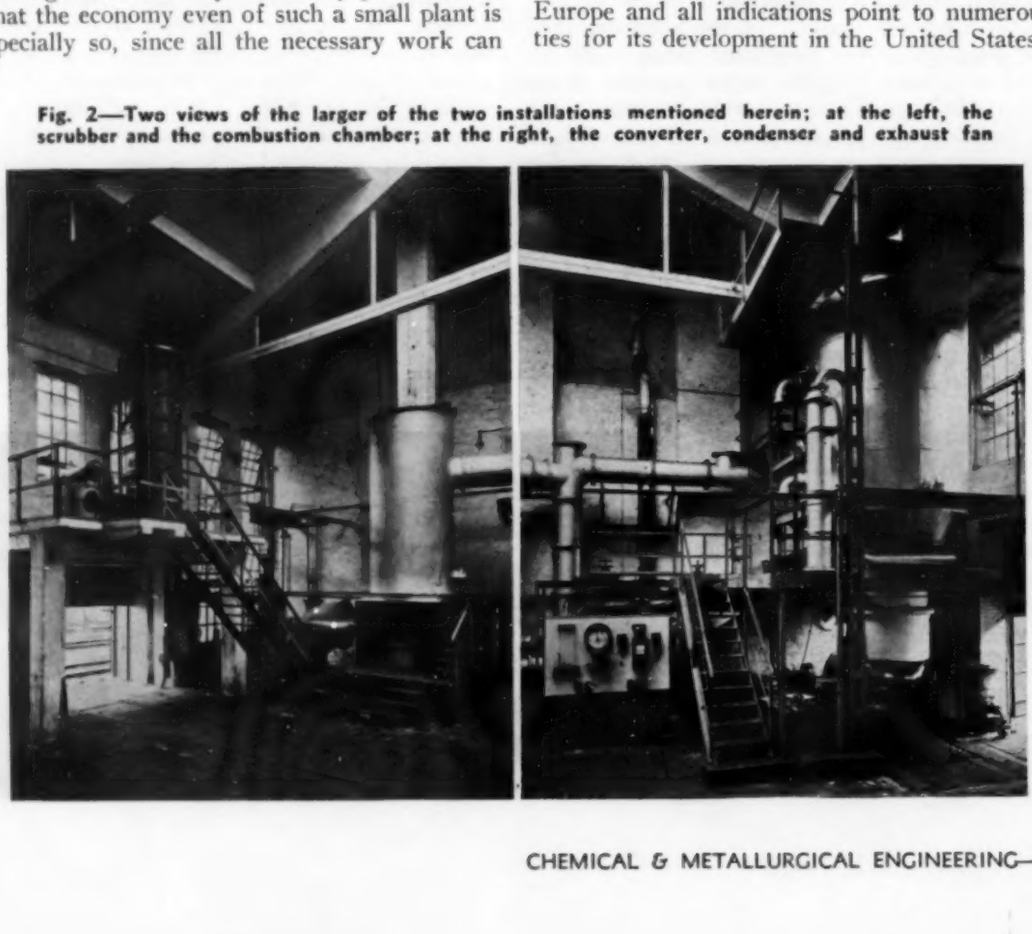
Following extensive laboratory experiments the first plant employing the wet catalysis process was erected in 1933 at the gas works in Frankfurt a. M., Germany. The purpose of this plant was to utilize for sulphuric acid production gases coming from the ammonium sulphate saturators and containing approximately 75 per cent by volume of CO_2 and 25 per cent H_2S. The daily production has been approximately 1 to 1½ tons of 60 deg. Bé. acid and the plant has been a complete success. It has become evident that the production of sulphuric acid from such gases is not only technically possible, but, above all, that the economy even of such a small plant is assured, especially so, since all the necessary work can be taken care of by one of the regular workmen, along with his other duties.

Another plant was put into operation in 1935 in a coke plant in the Ruhr district with approximately 7 tons daily capacity of 60 deg. Bé. acid. This likewise has proved satisfactory beyond expectations. The gas treated, in addition to such organic impurities as phenols, hydrocyanic acid and naphthalene, contains 16 per cent by volume of CO_2, 11 per cent H_2S, 14.6 per cent O_2 and 58.4 per cent N_2. The gases from the combustion chamber amount to about 775,000 cu. ft. per day, containing 4 to 6 per cent SO_2 and 10 per cent oxygen. The I. G. vanadium contact mass is used and a conversion efficiency of 95 to 98 per cent is obtained. The waste gases escaping to the open air contain only about 0.1 per cent SO_2 and are completely clear. The fan operates under a suction of 200 to 250 mm. w.g. and requires only about 30 kw.-hr. per ton of acid produced. No other power consumption is involved except in pumping cooling water to the condenser. No specially trained labor is needed and only part-time services of one man are required. Under German conditions a water white acid, which would be suitable for battery use, can be provided for feeding the saturators at a cost only about one-fifteenth that of purchased acid.

By means of the wet catalysis process it is possible to utilize profitably for the production of sulphuric acid gases heretofore considered as waste gases. Both initial plant investment and operating costs are reasonably low. It is not only possible to employ gases containing hydrogen sulphide, but similarly gases containing sulphur dioxide which are subject to fluctuations in their SO_2 content. If the gases do not contain sufficient moisture, it is easy to introduce moisture from the excess steam generated in the condenser.

This process has aroused considerable interest in Europe and all indications point to numerous possibilities for its development in the United States, as well.

Fig. 2—Two views of the larger of the two installations mentioned herein; at the left, the scrubber and the combustion chamber; at the right, the converter, condenser and exhaust fan



Applying Dialysis to Colloid-Crystalloid Separations

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TWO MISCIBLE LIQUIDS of different molecular weight, if separated from each other by a semi-permeable membrane, will gradually penetrate the membrane and become mixed with each other. This phenomenon of unequal diffusion through porous septums is called osmosis. The flow of the thinner to the denser fluid, such as water into a salt solution, is endosmosis; the slower flow in the opposite direction is exosmosis. A specific type of osmosis, called dialysis, takes place when a liquid containing a crystalline substance in solution, together with a non-crystallizable substance in colloidal solution, is separated by a semi-permeable membrane from pure water or some other liquid which is a solvent for the crystalline substance. The presence of these liquids on either side of the membrane results in a differential pressure between the two sides, known as osmotic pressure, and the dissolved crystalline substance will penetrate through the membrane into the adjoining body of water or other solvent until, theoretically, the concentration of the solution on each side is the same and the system is in osmotic balance.

The colloidal (non-crystallizable) matter also present in the solution to be dialyzed does not have the ability to permeate the membrane and thus it is possible to effect a separation of these two types of matter. This statement must be modified to admit that all colloidal solutions are not entirely lacking in ability to permeate or diffuse, but as their particle size is large in comparison with the molecules of true solutions, the rate of diffusion is very much slower than that of crystalloids.

In nature, osmosis and dialysis are indispensable to the growth and functioning of animal and vegetable bodies. As a unit operation in chemical engineering, dialysis as yet has not been widely adopted. It is not unreasonable to expect, however, that with a clear understanding of the principles and with the development of practical and efficient apparatus, this means of separating crystalloids from colloids or suspensions will find wider application.

Probably the earliest application was in the beet sugar industry where Nature herself provided the permeable membrane in the cell walls of the beet. By slicing the beets into small pieces and charging the pieces into a series of iron vessels called a diffusion battery, the crystalloid sugar is extracted by circulating warm water progressively through the battery, leaving the colloidal non-sugar matter within the beet cells.

Dialysis as a unit operation came in for serious development with the growth of the viscose rayon and transparent paper industries. The conversion of cellulose into alkali cellulose involves the use of large quantities of caustic soda. In the steeping press it is the practice to soak the cellulose sheets with a solution of caustic of 17-18 per cent concentration. The cellulose is capable of absorbing several times its weight of this solution, but is squeezed at the end of the steeping period to give it an exact caustic content, the weight of alkali cellulose discharged from the press being approximately three times the weight of the original dry cellulose.

The quantity of caustic solution used in the tank of the steeping press is very much greater than the amount finally removed in the alkali cellulose. This excess solution, at the end of the steeping period, is contaminated with caustic-soluble hemi celluloses and other matter extracted from the cellulose. In the case where the cellulose treated is cotton linters consisting of about 98 per cent alpha cellulose, the contamination of the caustic liquor is slight. But where the cellulose is wood pulp of lower alpha content and correspondingly higher hemi, the contamination is appreciable and renders a part of the steep liquor unfit for further use.

In the earlier days of the rayon industry when competition did not force strict economies, the recovery of steep liquor, if practiced at all, was accomplished by evaporation and subsequent incineration of the organic impurities mixed with the caustic soda. The increasing use of the cheaper and higher hemi wood pulps in place of or in mixture with cotton linters, however, indicated the necessity for more efficient and economical means of caustic recovery and resulted in the adoption of dialysis. This is now considered an indispensable operation in viscose manufacture, unless the impure caustic can be disposed of at a price for some other purpose.

To give a more detailed explanation of steeping press procedure for those interested in caustic consumption in the viscose products industry, it must be emphasized at this point that the entire quantity of liquor used for steeping is not subject to the alternatives of wastage or dialysis. For a batch of 220 lb. of scale weight pulp sheets the tank of the press requires about 300 gal. of caustic soda solution of 17-18 per cent concentration. At a specific gravity of 1.2 this is 2,988 lb. of caustic solution. The steeping press is fitted with a platen and hydraulic ram for squeezing the sheets at the end of the steeping period. Now the liquor initially charged must be divided into three parts mentally to conceive of its disposition. One part remains absorbed in the cellulose and is carried out of the press with it, to be converted many steps later in the process into sodium sulphate when the viscose is regenerated into cellulose in the acid spinning bath. This part amounts to approximately

Fig. 1—Large installation of Cerini dialyzers in the Venaria Reale plant of Snia Viscosa

double the weight of the original pulp, or between 400 and 440 lb. of 17 per cent solution. The second part, by far the largest proportion, is the excess liquor in the tank surrounding the pulp sheets. The third part is the liquor which has been absorbed in excess of the desired quantity by the pulp and which is squeezed out before the pulp is removed from the press.

In practice the ram of the press is run in against the pulp sheets for a certain distance, say to within 12 in. of the final stopping point, to squeeze out a certain proportion of the excessively absorbed liquor before the actual separation of the last two named parts is made by means of two different outlet valves. This large portion of liquor, called drainage liquor, is not seriously contaminated with the impurities of the pulp. It may contain 0.75 per cent hemi cellulose and be reduced in caustic concentration by about 0.3 per cent. The third portion, or reject liquor, is contaminated to the extent of about 1.9 per cent hemi.

This third portion is the liquor which must be purified by dialysis if it is to be suitable for re-use. It represents about 10 per cent of the quantity of liquor used for steeping, in excess of the amount carried out of the press by the alkali cellulose. The other 90 per cent or drainage liquor, is not only suitable for re-use when new NaOH is added to make up for the 0.3 per cent loss of concentration; it is actually required of the steep liquor that it have somewhere between 0.5 and 1.2 per cent hemi in it for proper treatment of the pulp—otherwise the ripening of the alkali cellulose will not proceed properly.

100 Per Cent Recovery Not Desirable

Another important point with reference to dialysis of steeping bath liquors in viscose plants is that a total recovery of caustic from the liquor to be treated is not wanted, even were it possible for the dialyzing apparatus to accomplish this feat. Hemi cellulose is soluble in weak caustic solutions but insoluble in water. The result of complete depletion of caustic from the impure liquor would be precipitation of the hemi, which in the course of time would gum up the membranes, channels, and drains. Therefore anyone claiming a 100 per cent recovery (or efficiency) for a dialyzer which he sponsors is offering the viscose manufacturer an apparatus which would be objectionable if not impracticable.

In contemplating the design of a dialyzer, the first problem is the selection of a suitable material for the membrane or diaphragm. Since we are dealing with caustic solutions, the ideal material should be resistant but pervious to caustic, as impervious as possible to colloids, strong enough mechanically to be handled without damage and to remain intact when held in place in the apparatus, and capable of permitting the fastest possible rate of dialysis per unit of area at a given osmotic pressure differential.

The second problem is to secure the maximum permissible extraction of soda from the impure solution without having the soda concentration of the recovered solution too low to be usable somewhere else in the manufacturing process or to be concentrated economically to the strength required for the steeping operation. The passage of the NaOH from the impure solution into the water on the other side of the membrane is caused by the osmotic pressure differential which is directly proportional to the difference in concentration of soda on the two sides of the diaphragm. If the two liquids are confined to a container an equilibrium eventually will be attained when both solutions have the same concentration and the recovery in this case will be 50 per cent of the crystalloid. To effect recoveries approaching the theoretical 100 per cent, it is obvious that the liquid on the water side of the membrane must be carried off continuously so that its concentration shall be always less than the diminishing concentration of the impure solution; and that a constant feed of the impure solution on its side of the membrane will help still more to maintain the osmotic head. Thus continuous operation, so highly desirable in most chemical engineering processes but not

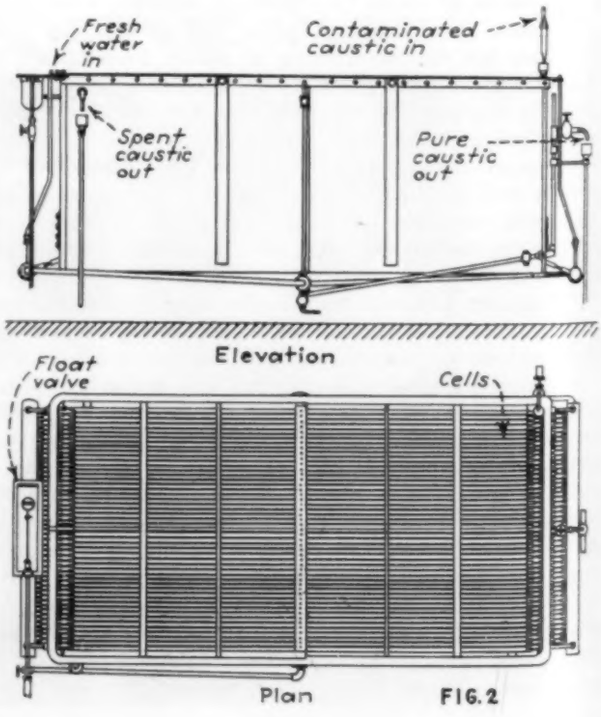


FIG. 2

always attainable, is clearly indicated as necessary in the case of dialysis.

The third problem has to do with the general design of the apparatus to the end that it will occupy the minimum floor space per unit of capacity and have the membranes or diaphragms so arranged that they are accessible for replacement without too great consumption of time and labor.

Examining now how these problems have been met by the inventors of dialyzers, we find a variety of materials that have been advocated and tried as semi-permeable membranes. The earliest United States patent, to our knowledge, is 1,573,703, issued to F. H. Griffin and assigned to The Viscose Co. Griffin reveals that durability and efficiency are best obtained by the use of parchmentized woven fabrics made by immersing cotton sheeting in sulphuric acid of 1.1 specific gravity at a temperature of less than 30 deg. C. for two minutes, followed by neutralization or water washing.

Leonardo Cerini, in his U. S. patent 1,719,754, uses diaphragms made of a fabric of vegetable fiber mercerized by the action of alkalis, for example, a concentrated solution of caustic soda. Later, in his U. S. patent 1,815,761, after listing porous porcelain, cement plates, asbestos cardboard, and parchment paper as materials which had been tried and found unsatisfactory, he carries his mercerized fabric a step further. Cellulose hydrates formed by action of caustic alkalis are gradually soluble in water, but those derived from earth metals, earth alkali metals, or compositions of metals having similar effect can be made less soluble or even entirely insoluble in water and alkalis. He either treats diaphragms with these metallic salts, or applies organic metallic compositions of colloidal nature after the first treatment. Alternatively, the second treatment may be made with compositions insoluble in water and alkalis, such as resinates of metals, particularly of earth metals. Treatment with magnesium salts and rosin solutions

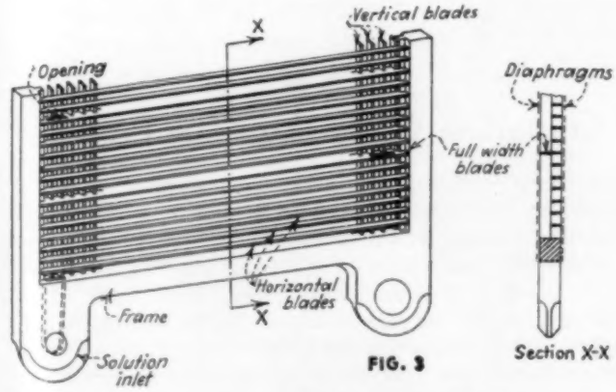


FIG. 3

Fig. 2—Plan and elevation of 50-cell Cerini dialyzer

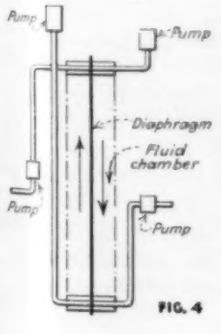


FIG. 4

Fig. 3 — Heibig dialyzer frame designed for turbulence and flow control

Fig. 4 — Schematic cross section of Asahi counter-flow cell showing use of pumps for pressure balancing

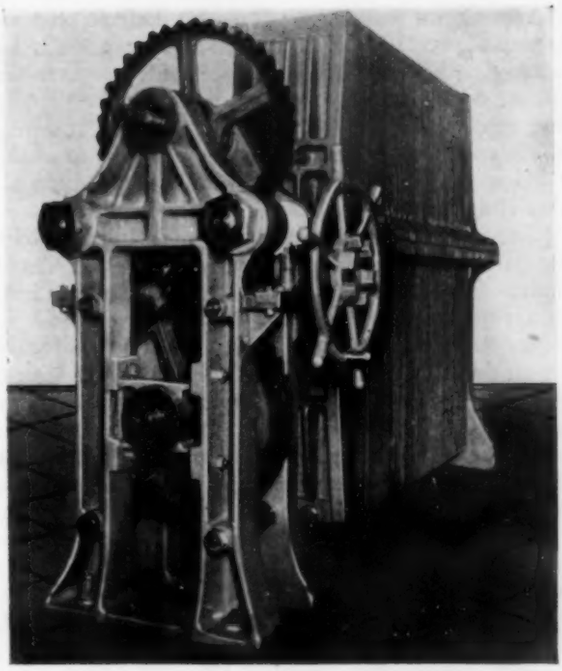


Fig. 5—Typical Asahi dialyzer, having a capacity of about 200 tons of 100 per cent caustic per year

is said to give good results, an organic colloidal composition thus being formed upon the fabric.

Fabrics such as those described in the above three patents have the drawback that their thickness precludes a rapid rate of dialysis. It has long been known that ordinary parchment paper, such as that manufactured for wrapping butter and other food products, is an excellent dialyzing membrane and probably the least expensive. Its use in sheets of large enough area to make commercially practical dialytic cells, however, was retarded by its comparatively low strength and resistance to bursting strain, necessitating a backing support of wire mesh or perforated metal which thereby reduced the effective dialytic area. Shozo Tachikawa, in U. S. patent 1,868,955, found a way to overcome this difficulty. He proposed to use very thin, unsupported parchment paper membranes by inducing a pressure on one side of the membrane to equalize or compensate for the pressure on the other side caused by the osmotic differential, as will be described presently.

Fundamentals of Commercial Designs

In general, commercial dialyzers may be classified into two main types—the rectangular tank and cell type and the filter press type. The Griffin and the Cerini designs fall into the former class; the Heibig and the Asahi (Tachikawa) into the latter.

In the Griffin dialyzer the impure caustic-hemi solution is flowed through a series of dialytic cells and the pure water is contained in the tank in which the cells are suspended. In the Cerini dialyzer the pure water flows through a number of cells while the liquor to be dialyzed is circulated through the tank.

The Cerini apparatus which is extensively used by the domestic viscose industries, has previously been described in detail (*Chem. & Met.*, Sept., 1935, pp. 482-5). A

typical Cerini dialyzer employs 50 dialytic cells and occupies a space 10 ft. 2 in. long, 5 ft. 3 in. wide and 4 ft. 1 in. high. Each cell is composed of two parchmentized cotton cloths sewed together to form a flat, rectangular bag supported internally by a suitable wire screen. Such a dialyzer has a total dialyzing surface of 300 sq.m. (385 sq.yd.) and an output of 200 to 250 kilos of purified NaOH per 24 hours.

The view of Fig. 1 shows a large installation of Cerini equipment, one of several owned by Snia Viscosa, in Italy. Fig. 2 portrays the type of construction employed in a 50-cell unit. Referring to the drawing, the impure liquor enters at the bottom of the tank at one end and leaves by an overflow port located at the top of the tank on the opposite end. The liquor leaving by this overflow has been divested of most of its caustic but contains the impurities extracted from the cellulose and is run to waste. The pure water enters the group of cells in parallel through an inlet in the top of the cells, leaving generally from the two bottom corners. Through the use of counterflow the osmotic pressure differential is maintained along the entire flow path. Furthermore, the changing densities of the liquors are utilized to provide flow entirely by gravity. The volume of pure caustic solution delivered is about twice that of the impure liquor fed to the tank. When operated for maximum efficiency, the unit delivers a pure solution containing 7-8 per cent NaOH. Any one of the cells can be isolated without shutting down the whole apparatus and the diaphragms have a life of 9-12 months in constant service. Only nominal attendance is required for operation.

A patent granted Edouard Heibig of France on March 15, 1932, (U. S. P. 1,849,622) described an improvement in dialyzers of the filter press type. The inventor points out that osmotic action in a dialytic cell is restricted to the immediate vicinity of the membrane and that diffusion of the more concentrated solution in the central portion between membranes into the less concentrated solution is rather slow. Also the velocity of flow is greater in the central portion than adjacent to the membranes where friction restricts velocity. This condition could be improved by making the frames very thin, but this is impractical. He proposes insertion within the frame of a set of horizontal and vertical blades or slats, as in Fig. 3, to form the backing or support for the diaphragms, reduce the capacity of the frame, and compel a turbulent circulation, thus bringing all of the liquor in contact with the diaphragms. These slats are of about half the width of the frame, so that the diaphragm on one side is in contact only with vertical slats and that on the other side only with horizontal slats. A few of the slats may be of the full width of the frame, with openings at one end only so as to induce a zig zag circulation throughout the whole chamber. This arrangement is said to increase the yield 10-15 per cent over frames of the same area not so equipped.

The Asahi dialyzer, illustrated in Figs. 4 and 5, represents the filter press type of construction in its most modern form and permits the greatest output per unit of floor space occupied of any dialyzer so far in commercial use.*

*The Casey dialyzer, not yet in commercial production, in experimental models is said to have shown considerably larger capacity than the Asahi. This dialyzer (see *Chem. & Met.*, July, 1935, p. 394) consists of ten units in series, each comprising a vertically arranged assembly of horizontal frames separated by parchmentized fabric diaphragms into alternate caustic and water compartments. Counterflow is provided and turbulence assured through the use of a number of perforated feed pipes within each compartment.—Editor.

Typical Performance and Labor Requirements of Asahi Dialyzer

Rate of flow, water in	3,780 c.c. per minute
Rate of flow, caustic in (19.2 g. per 100 c.c.)	2,040 c.c. per minute
Rate of flow, waste out (1.5 g. per 100 c.c.)	2,200 c.c. per minute
Rate of flow, pure caustic out (9.9 g. per 100 c.c.)	3,620 c.c. per minute
Efficiency	92 per cent
Time required to unload and clean	2 men, 3 hours
Time required to dress	3 men, 1 hour
Time required to re-fill	1 man, 2 hours
Total man-hours	11
Cost of parchment paper for re-dressing	$1.68
Total labor	$5.50

It has 121 steel frames mounted on rails and compressed together by a hand wheel and gearing. Space occupied is 6x17¼ ft. For the dialytic membranes it uses parchment paper of about 0.04 mm. thickness weighing 40 grams per square meter, and measuring 1,561 mm. long x 520 mm. wide. The apparatus is capable of taking an input of 3,000 liters of 17 per cent caustic liquor per 24 hours. The output is equivalent to about 200 tons of solid purified NaOH per year.

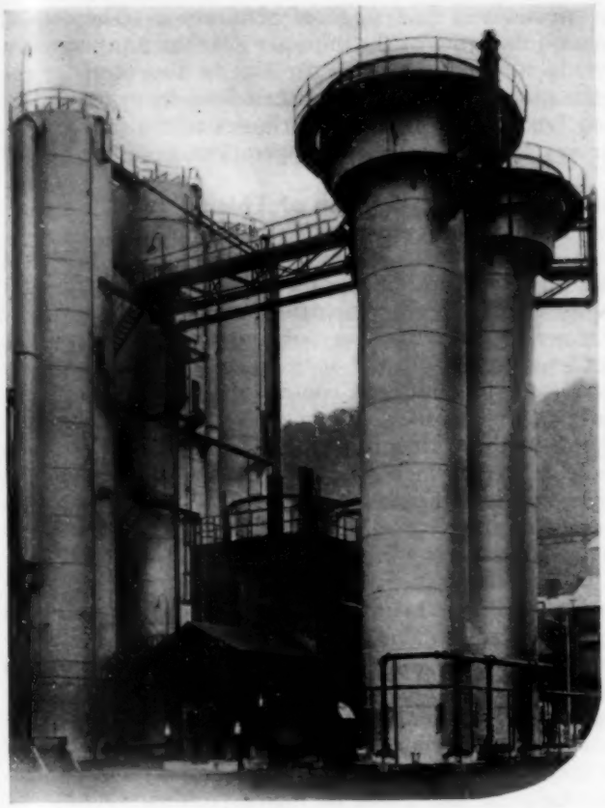
The principle on which the Asahi operates with such thin, comparatively fragile membranes is that of balancing the unequal pressures which would be set up on either side of each diaphragm on account of the osmotic differential, the density difference, and the velocity difference of the two liquids. This balancing or compensation of pressures is accomplished by means of four small gear pumps, two for water and two for caustic solution. These are supplied with change gears for speed regulation and require only ¼ hp. The pumps operate at between 5 and 7 lb. per square inch pressure. The principle is illustrated in Fig. 4 which shows a section through a single cell with the two liquids running counterflow. Either pumps or stand pipes with different hydrostatic heads may be employed for the pressure compensation.

The life of parchment diaphragms is 25-30 days. About 7 hours is required for changing diaphragms and 4 hours thereafter to refill the cells.

The records of a plant run on one Asahi dialyzer appear in the accompanying tabulation. Since this run was made shortly after installation, better results are expected of later trials.

Crystalline Caustic by New Process

A highly soluble, crystalline caustic soda, which is anhydrous and freer of sodium carbonate and chloride than the ordinary fused product, has been produced on a semi-works scale by a new process recently developed in the laboratory of Autoxygen, Inc., New York. Free flowing crystals, the size of which can be accurately controlled within limits by the proper degree of agitation, are produced by a process of partial pressure distillation and what has been termed "fractional spray crystallization." Caustic liquor, as it comes from the evaporator, is agitated with an inert, immiscible organic solvent and distilled so that water evaporates from the caustic droplets suspended in the solvent and the solvent boils, both below their respective boiling points. Owing to the lesser solubility of the carbonate and chloride it is expected that a good separation from the caustic will be possible by isolating the various crystal fractions. Because of the reduced temperature during evaporation, manufacturing economies in comparison with the fusion process are expected to result.



Two-stage Thylox plant, for removal of hydrogen sulphide from gas, of the E. I. duPont de Nemours & Co. at Belle, W. Va.

By A. R. POWELL
The Koppers Construction Co.
Pittsburgh, Pa.

Removal of Hydrogen Sulphide From Gas

DURING the early part of 1935, The Koppers Construction Co. erected a two-stage Thylox liquid-purification plant for E. I. duPont de Nemours and Co. at their works in Belle, near Charleston, W. Va. The plant was designed to remove substantially all of the hydrogen sulphide from 45,000,000 cubic feet per day of blue-water-gas.

This plant is especially interesting from two standpoints. First, it is the first large plant to be operated that secures substantially 100 per cent removal of H_2S by liquid purification alone, without the auxiliary use of iron-oxide boxes. And, second, it has the largest capacity of any liquid-purification plant in the world, to the best of our knowledge.

The duPont plant at Belle went into operation in June, 1935, and has been operating continuously since that time. A general view of this liquid-purification plant is shown. At the left are the absorbers, three in number, each having a capacity of 15,000,000 cubic feet per day. At the right are two pressure thionizers which regenerate the primary solution circulated through the three absorbers. Between these two sets of towers is the brick building that houses the pumps, air compressors, sulphur-filtering equipment, control laboratory, instrument board, and other accessories.

Each of the three absorbing towers is 15 feet in diameter and 90 feet high, and the gas flows through them in parallel, each tower handling 15,000,000 cubic feet per day, making a total capacity of 45,000,000 cubic feet. Both the inlet and outlet gas connections are 36-inch pipe. At the lower left-hand corner may be seen one of the baffle-type moisture eliminators to remove any possible solution spray in the outlet gas. The primary-solution pipes may be seen entering the absorbers about two-thirds of the distance up the towers. These pipes receive the solution from a weir box, which, in turn, is supplied with solution by gravity feed from the top of the thionizers. At the point where the primary-solution lines enter the tower there is a balcony or recess, the entrance to which is on the other side not shown in the photograph. This balcony separates the primary absorber from the secondary absorber in each tower, and the gas is carried through the center of it by means of a 36-inch pipe. The inlet secondary-solution lines may be seen entering the towers at the top. The outlet lines for the recirculating secondary solution leave the tower just above the balconies on the other side.

In the base of each tower there is a solution reservoir with a conical bottom having an outside level indicator, so that any irregularity in flow of the primary solution in the system may be balanced. Two pumps, one operating and one spare, are provided to pump the primary solution from the bottom of the absorbers into the bottom of the pressure thionizers. Each of these pumps has

Based on paper presented before the American Gas Association's Joint Committee Conference of the Production and Chemical Committees at New York, May 27.

a capacity of 150,000 gallons per hour against a differential head of 90 feet. Also two pumps, one operating and one spare, are provided to recirculate the secondary solution. Each of these pumps has a capacity of 75,000 gallons per hour against a differential head of 60 feet. Standard wood hurdles have been provided as tower filling in each of the absorber sections, and also the proper number of spray nozzles have been installed at the top of each absorber.

The entire plant has been integrated into one unit, as far as the flow of solutions is concerned. The foul primary-solution from the bottoms of all three absorbers joins into one stream of flow which is then pumped into the bottoms of the two pressure thionizers shown in the right of the figure. The thionizers are in parallel, each one taking one-half of the solution flow. Also, the actified primary solution from the tops of the two thionizers joins in the weir box for redistribution into the primary absorbers. The foul-solution by-pass also enters the weir box.

Thionizers

The outer shell of each of the pressure thionizers is 12 feet, 6 inches in diameter and 66 feet high. Inside of this outer shell is a concentric inner shell that is 6 feet in diameter and slightly higher than the outer shell. The annular space between the outer and inner shells is divided into two equal compartments of semi-annular cross-section by means of two vertical steel partitions. The foul solution from the primary absorbers is pumped into the bottom of one of these semi-annular compartments and flows upward. This compartment is supplied with compressed air at the bottom, and the first stage of solution actification takes place in this pass. The solution flows out of this compartment near the top just under the blanket of sulphur foam and passes into the top of the circular inner compartment where it flows down to the bottom of the thionizer again. This circular inner compartment is not supplied with air, but serves the double purpose of bringing the solution to the bottom of the thionizer so that it may again pass up through an actification compartment and also allows a time factor for some of the oxygen absorbed in the first stage of actification to chemically react with the Thylox compound. From the bottom of this circular inner compartment the solution flows into the bottom of the second semi-annular compartment and again passes upward together with compressed air supplied at the bottom. This constitutes the second and final stage of actification. The actified solution flows out of the thionizer near the top just under the sulphur-foam blanket present on the second stage actification compartment, and then flows by gravity to the weir box from whence it distributes to the primary absorbers for another cycle of operation.

Cross-Section of Thionizers

In order to keep the distribution of the air bubbles uniform over the semi-annular section of the thionizer compartments, each compartment is divided into three sections by vertical steel partitions arranged radially. These partitions are not solution-tight, since they serve merely as guides for the control of the flow of air bubbling up through the solution. A horizontal cross-section of the complete thionizer would appear, therefore, as a circle 12 feet 6 inches in diameter, with an inner concentric circle 6 feet in diameter. The space between the outer and inner circles is divided into six equal sectors by radial lines representing vertical partitions.

At the top of each thionizer is a skimming tank supported from the thionizer shell. This skimming tank is about 18 feet in diameter by 8 feet deep. As the sulphur foam overflows the top of the thionizer it runs down to the periphery of this tank, which is provided with a sloping slurry trough. This trough carries the sulphur slurry to a drain pipe, which then carries the slurry by gravity to the slurry tank. The top of this slurry-storage tank may be seen just above the brick building between the absorbers and thionizers. The slurry-storage tank has a working capacity of 10,000 gallons and is provided with a conical bottom. The sulphur slurry flows directly from this tank down into the building where the filter is located.

The filter for the sulphur slurry is an Oliver continuous vacuum filter with a filtering drum 3 feet in diameter by 4 feet wide. The effective filtering area is 36 square feet. The usual accessories, such as vacuum pump, filtrate pump, receiving tank, etc., are provided. Above the filter drum are several water sprays for washing the sulphur cake before it is discharged from the filter, and the use of these sprays has been very effective in producing a cake that is unusually low in soluble salts, arsenic, and other impurities. The slurry fed to the filter contains about 5 per cent sulphur in suspension, and the sulphur cake leaving the filter contains about 50 per cent.

As the sulphur cake is discharged from the filter drum it falls into a hopper, and thence into a sulphur melter

Operating Results From duPont Plant at Belle, W. Va.

	GAS				PRIMARY SOLUTION			SECONDARY SOLUTION			
		H_2S (gr./100 cu.ft.)									
Day	Volume M cu.ft.	Inlet	Outlet Primary	Outlet* Secondary	Gal./M Total	Gal./M Bypassed	Temp. °F.	As_2O_3 Content %	Actifier Air cu.ft./M	Gal./M	Temp. °F.	As_2O_3 Content %
1	22,600	75	10	Clean	68	13	96	....	40	50	95	....
2	17,900	70	..	Clean	91	20	93	....	37	69	93	....
3	21,000	63	..	Clean	75	18	95	....	26	58	94	....
4	21,500	60	3	Clean	67	17	96	0.33	38	57	94	0.85
5	21,100	63	..	Clean	75	7	95	0.28	40	57	94	0.83
6	20,300	62	3.5	Clean	110	24	95	0.30	42	56	93	0.80
7	23,500	67	3.5	Clean	97	27	96	0.27	36	50	95	0.70
8	24,100	60	2.5	Clean	96	25	95	0.25	36	51	95	0.63
9	21,500	50	2.5	Clean	101	25	95	....	39	56	95	....
10	21,200	57	..	Clean	102	26	95	....	39	..	95	....
11	21,300	53	2	Clean	103	25	96	0.30	39	61	95	0.77
12	21,700	55	2	Clean	101	24	95	....	38	59	97	....
Av.	21,500	61	3.5	Clean	90	21	95	0.29	38	57	95	0.76

* "Clean" means that the gas was consistently clean when tested with lead acetate paper for one minute by the standard test. Several quantitative tests showed that the H_2S content was about 0.05 grains per 100 cubic feet.

where pipe coils heated by high-pressure steam evaporate the water and melt the sulphur. The usual type of autoclave is not used at this plant. The molten sulphur is periodically withdrawn and cast into a large pan where it solidifies as brimstone. This brimstone casting is then broken up into large lumps and is ready for shipment or storage.

The above description of the two-stage Thylox plant at Belle brings out some of the more important features of construction. Certain other details, such as fresh-solution mixing tank, the fresh-solution pump, the solution heater, the air compressors, the various meters and indicating and recording instruments, the means used to secure equalized air-flow into the bottoms of the thionizers, and many other features of this plant, will not be described because the description would become too lengthy.

Pleasing Features

One of the pleasing features of this plant is the liberal provision of stairways and platforms so that all the major portions of the plant may be reached by the operators without having to use ladders. The various towers are finished in aluminum paint, which gives the entire plant a clean, well-kept appearance.

Shortly after the duPont plant at Belle was put into operation, a continuous operating test was made, and rather complete operating data were obtained. These are given in the table. It will be noted that the plant was handling at that time only about one-half of the gas called for in the rated capacity of 45,000,000 cubic feet per day. However, only two out of the three absorbers, and only one of the two thionizers were operated during this test period, so that the conditions were practically equivalent to full capacity. The H_2S in the inlet gas was rather low at this time, but at other periods the plant has successfully purified gas having about twice the H_2S content shown in the table, which can be seen on page 308.

About 95 per cent of the H_2S was removed in the primary absorber, and the remainder, down to the point where lead-acetate paper gave a negative test, was removed in the secondary absorber. As a result of these tests with blue water-gas, it was discovered that the standard lead-acetate-paper test is considerably more sensitive with blue water-gas than it is with coal gas or carburetted water-gas. Ordinary city gas usually will not produce a stain until the H_2S concentration exceeds 0 3 or 0.4 grain per 100 cubic feet. With the blue water-gas being purified at the Belle plant, it was found that a stain usually appeared at about 0.1 grain per 100 cubic feet. The outlet purified gas from the Belle plant was, therefore, lower in H_2S content than is the gas from many iron-oxide-box installations.

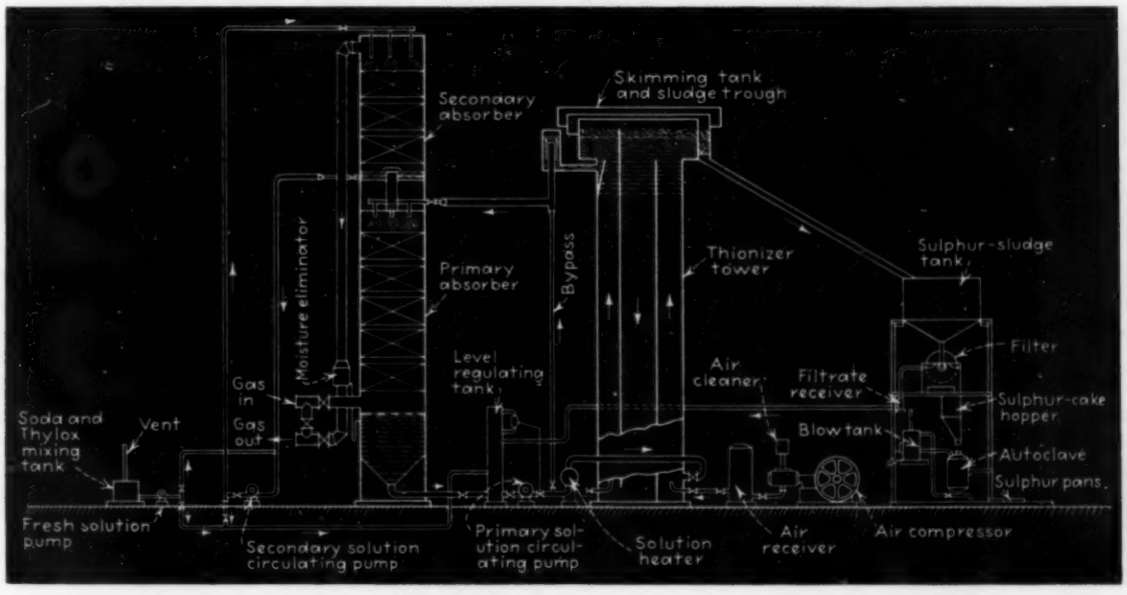
Both the figures for total primary solution circulation per M cubic feet of gas and for the by-passed solution are given. The total circulation represents the solution flowing through the absorbers, whereas the solution flowing through the thionizer is the difference between the total and the by-passed solution rates.

The arsenic contents of both the primary and secondary solutions were quite low, since strong solutions are not necessary, due to the low H_2S content of the inlet gas. For the same reason, the actifier air used in the thionizer was much less than would be necessary for gas with a higher H_2S content.

Cost of Operation

Summing up the two-stage Thylox plant at Belle, it can be stated that the purification of blue water-gas over a period of several months has been very satisfactory, The outlet purified gas from the Belle plant was, theredoes the average iron-oxide-process plant, and the cost of operation has been very considerably less than for an equivalent iron-oxide-box installation.

Flow diagram of the two-stage Thylox process for the complete removal of hydrogen sulphide from gas



WHITHER ENGINEERS?

AND

ENGINEERING EDUCATION?

By WEBSTER N. JONES
Director, College of Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

Editor's Note:—Why do some men get ahead in industry? Why do others fail? What does the average industrial employer expect of recent engineering graduates? How does he look at such criteria as scholarship, personality, extra-curricular activities? Is graduate training worth the price? If so, for whom? These are some of the questions answered in a very human and constructive way by an engineer who has done much to bring industry and education to a basis of better understanding of the mutuality of their interest and purpose.

ALMOST four years have elapsed since I became associated with the Carnegie Institute of Technology. Today my duties in connection with my position become more interesting, more important, more vital; each month my circle of friends widens to encompass students, faculty, alumni, and citizens of our industrial community; and each year my respect and admiration for engineering education increase. It is a source of great personal satisfaction to me to know that I am part of the work of conditioning young men and women for the diverse and unlimited responsibilities which our modern, complicated, technological era forces them to share. May I, therefore, take the opportunity to carry a step nearer to industry the thoughts that were in my mind in 1934 (see *Chem. & Met.*, Sept., 1934, pp. 462-3) when I reviewed the outstanding trends, as I saw them then, in the field of engineering education? This time, however, I should like to concern myself more directly with the product than with the educational process, more with market specifications and requirements than with the mechanics of curricula and courses of instruction.

First I should like to quote from authoritative sources some views regarding the importance of scholarship which I know to be contrary to popular but uninformed opinion. Investigations by the Research Laboratories of the Bell Telephone Company and by the Massachusetts Institute of Technology, clearly indicate that men who have shown serious, scholastic attainments in college obtain better positions and greater financial reward than men who have shown mediocre ability in the classroom. "Good marks and social popularity in college are both apparently predisposing factors to a high salary later in the business world. An analysis of the careers of some eight hundred graduates of the Massachusetts Institute of Technology's Department of Business and Engineering Administration between the years 1917 and 1930, shows the top group in earning capacity as more likely than their less successful classmates to have been fraternity members and to have had high grades, especially in business and economic subjects. Moreover, despite the great American tradition, those who started lowest on the financial ladder show the least tendency to work up. The sought-after, scholastically superior man secured the best jobs after graduation and rose most rapidly, while those who had the poorest offers at first remained at a low salary level."

Thomas B. Spooner, assistant director of research of the Westinghouse Electric & Manufacturing Co., in "The Characteristics of a Group of Engineers," made a critical examination of the weaknesses of the technical men who were released during the depression. The characteristics were listed under three main headings: temperamental traits, misapplication and training. The outstanding weaknesses under temperamental traits, were diffidence, unimpressive personality, lack of initiative, lack of aggressiveness and not sufficient evidence of ambition. The principal weaknesses under misapplication were lack of ingenuity and resourcefulness as well as of ability. The outstanding weakness under training was failure to improve oneself technically. It is rather startling to find, I think, that 84 per cent of the engineers released had temperamental faults of one kind or another.

Mr. Spooner states that when he "attended technical

school, he was led to believe, by inference at least, that to be a success the one thing necessary was to study hard and to master the fundamentals of science and technology. The development of personal traits and the correction of temperamental faults scarcely were mentioned and certainly were not stressed. Perhaps more could be done by the schools in the formative period to bring home to the students the importance of their relations to their fellow men, not only from a social standpoint but as a means of holding their jobs and advancing in their chosen profession. After a man becomes older it is usually too late to influence appreciably these characteristics!

"No matter how brilliant a man may be, he cannot be successful in group activities unless he can obtain cooperation. He must have the respect and liking of his fellow workers. For his greatest success he must be sufficiently aggressive to convince others of the value of his activities and to some extent, at least, he must sell himself to his superiors."

What does industry demand of our engineering graduates? What are the specifications that we of the universities are being asked to fill? Perhaps these questions can best be answered by excerpts from a few typical letters from industrial concerns selected more or less at random from an ever-increasing volume of correspondence that comes to our placement bureau.

1. A large soap company.

We would like to select two or three men who have been out of college for a few years and who have some aptitude for our type of work. Some experience and formal training in industrial relations work is desirable but not essential. It is essential, however, that the men have high mental alertness and unusually acceptable personalities. We prefer men under thirty. We will probably place these men initially in our central industrial relations division and then transfer them to our factories for further training.

2. An alloy steel producer.

We have an opening for an engineering graduate with the following qualifications: (1) One or more years' experience, preferably in the steel industry; (2) A graduate of either commercial engineering, mechanical or works management departments; (3) Scholastic standing within the range of the upper third of the class.

3. A prepared roofing manufacturer.

We are looking for men: (1) 24 to 30 years of age, passed the schoolboy stage, and approaching technical maturity. Preferably single. (2) At least three years of engineering schooling and three years of practical experience. (3) Good personality and good mixers. Industrious and temperate (not necessarily abstemious) habits—a man's man. (4) Neat appearance, preferably 5 ft. 10 or taller. (5) Must be able to express themselves well and fluently; with accurate, neat and meaningful drawings or in written or spoken English. (6) Must be possessed of creative imagination and be reasonably ambitious. (7) Must have a good working knowledge of the problems of natural fan ventilation and air conditioning in industrial plants; and after a few months' training be able to make field surveys and engineering recommendations in the solution of such problems.

Moderate starting salary. Opportunities for further advancement limited only by general business conditions and the man's own ability to produce. Working condition and environment generally regarded by our employees as excellent.

4. A chemical equipment maker.

We are looking for a young man who is seeking a future with an old established concern and with whom salary is not the prime consideration, at the start. Mechanical aptitude and training are essential and intelligent, aggressive ability to sell is necessary. We are looking for an educated man who has "found" himself, has passed the young college period and who can think for himself, has poise and address with a deep-seated, aggressive, tenacious urge and determination to get ahead.

5. An instrument-making organization.

We are interested, as you will recall, in graduates with a good scholastic record, pleasing personality, good appearance, and those who have engaged in some extra-curricula activities. These men might be among any of your engineering graduates, since we believe we could adapt good fundamental engineering training toward this line of work.

6. A mechanical engineering publication.

Primary qualifications: (1) High-rank engineering student; (2) Skill in the use of English (able to develop a forceful, clear, and easy style of writing); (3) Strong inclination toward self-expression, particularly through the printed page; (4) Native skill with a pencil, some fondness for free-hand sketching, a sense of characteristic balance, ability to size up the quality and presentation possibilities of drawings and photographs. (5) Interest in typography, engraving and printing processes. (He will not be expected to be expert in these matters at the start.) (6) Exceptional inventiveness, resourcefulness, ingenuity. (7) Ability to work easily with other men, to meet engineers, to assume responsibility, to adapt himself quickly to constantly changing conditions. (8) Dependability, courage, mental and physical energy, good health. Other desirable qualities and background: (1) Some experience on college newspaper or technical magazine; (2) Ability to read technical German. (3) Wide range of human interests; (4) Some first-hand contacts with the life and men of the working world in business or industry.

7. A large oil company.

Our need is for a young man with initiative having a basic, well-rounded engineering education and with considerable aptitude toward sales work. Engineering as involving mathematical computations does not enter into the requirements to any appreciable extent. We point this out as there are two broad classes of engineers, viz. (a) Those who are primarily interested in production and factory management, and (b) Those who are primarily interested in the marketing of a product to be used for engineering purposes.

While we want initiative and appreciate ambition, still the men we are looking for must be patient and willing to grow relatively slowly as they acquire experience in our business. As you appreciate, we are a very large corporation and progress of our employees is relatively slow and steady. Executive positions are almost entirely filled with men who have developed with the company after long years of experience. A new man will always find a safe and fair living standard with the opportunity of going ahead. He must appreciate that it will be some time before he can return any real value to us and become thoroughly familiar with the special problems involved in marketing quality products and consequently we are not looking for someone who believes in frequent changes of position to make rapid progress.

8. Another petroleum producer.

We are interested in three classes of engineers: (1) Those who have majored in mining engineering, however being well grounded in mathematics, physics, and kindred subjects; (2) engineers who have a detailed knowledge of physics and mathematics, as well as other engineering subjects. These engineers would be assigned to production engineering problems after they had finished their field training. (3) Mechanical engineers who have had some courses in mining engineering, physics and mathematics, as well as the other courses common to mechanical engineering.

These eight typical letters bring out many of the essential qualities that industry is seeking in engineering graduates. A summary of these and other letters leads me to the following list of characteristics that determine the future of the individual engineer seeking industrial employment:

Fundamental and well rounded engineering training	Designing ability
Shop experience	Mechanical ability and aptitude
Good, pleasing, serious, and acceptable personality	Good character
Ability to work with others	Good health
Ability to write logical letters and reports	Neat appearance and good address
Ability to read German	Willingness to assume responsibility
Participation in extra-curricula activities	Fluency in spoken English
Analytical mindedness	Wide range of interest
Ingenuity	Mental alertness
Determination	Creative ability
Stability	Initiative
Poise	Industry
Accuracy	Courage
Companionship	Aggressiveness
	Tenacity
	Dependability

A question that bothers me somewhat as an engineering educator: Why is it that so few engineering graduates enter upon a program of advanced study? Is it because they have had such a concentrated dose of learning in their undergraduate days that they do not feel equal to the task of three years of further study to obtain a Ph.D. degree? Is it because the financial reward is not sufficiently attractive for those who have ventured advanced study? Is it because industry has not awakened to the value of better-trained engineers? Or does the type of undergraduate engineering training dull a student's desire for research work and accentuate his bent for practical application?

In this connection I was much interested in a statistical report of the American Council on Education. During the five-year period 1928-32, there were conferred in the colleges of the United States 483 doctorates in physics; 1,434 in chemistry; 134 in chemical engineering; 15 in civil engineering; 55 in electrical engineering; 15 in mechanical engineering; and 41 in mining and metallurgical engineering. My prediction is that the engineering college will soon demand graduate training of those who are appointed to teachers' positions and that industry will gradually require advanced work of its engineers, especially of those who enter the experimental and research departments.

I find there is considerable impatience among young men who are graduating from college. They are anxious to go to work to do something productive, and it is difficult for them to see the desirability of continuing their studies. To young men who have the financial backing, I usually tell the story of the training of one of my close personal friends, Dr. E. K. Bolton, who devoted many years of his life to the acquisition of an education before he entered industry. After four years' undergraduate work at Bucknell University, he spent five years in graduate study at Harvard before he obtained a Ph.D. degree. What fortitude, tenacity of purpose, and vision it takes to devote so much additional time to graduate study in preparation for a hoped-for position of which seemingly there is no assurance! After he had obtained his Ph.D., Dr. Bolton was awarded an Austin Traveling Fellowship and spent two additional years in Germany, studying there under Willstatter. Upon his return to the United States, he declined a teaching position in order to affiliate himself with the duPont company. His accomplishments in technology and his comprehensive understanding of people merited, in the short span of fifteen years, his promotion to the chemical directorship of this great chemical organization.

Now, whither engineers in industry? Suppose a student goes immediately from college to industry, what opportunities are open to him? With the return of better business, all of our institutions of higher learning are being visited by industrial scouts. Industry is searching for men of scholarship and character. Many training schools have been developed for engineers who are carefully selected from preferred colleges and universities—special recognition being invariably given to students doing graduate work. It is the policy of these companies to select the better trained men from a large number of widely scattered institutions in order to avoid clannishness and to compensate for whatever differences there are in educational methods. Recent graduates are not usually required to have experience in the specific industry's technology. During a preliminary training period in any given plant, the college and university graduates are given manual work in the various production departments in order to become acquainted with production operations, methods and costs. Frequently a specially prepared textbook dealing with the industry is made available for study and forms the basis for discussion classes. Throughout the course, attention is given to the economic aspects as well as the scientific principles and practical methods, since a knowledge of costs of materials, manufacture and distribution is often of great importance to the engineer. The training course is directed and managed by technically trained men, experienced in the industry, who understand the problems of the new man and who are competent to guide and assist him during this period.

After he has gone through a factory training course, the new man has a distinct advantage over one who started at the same time and immediately began laboratory work. The graduate of the training course has made contacts throughout the organization; he has become acquainted with some of the factory men; he has learned a great deal about lines of organization; and he has accumulated much detailed information about the industry, its methods, processes, and equipment. This experience affords the young engineer an opportunity to determine the kind of work in which he has the greatest interest, and he is thus able to direct his efforts in being assigned to the work he likes best.

It has been interesting to me to observe the change in attitude of industry toward the technical men in recent years. In the depression of 1921, the first department to suffer in many industries was research. The drastic curtailment of research at that time showed a near-sighted policy and ultimately resulted in almost irreparable economic loss. During the period 1930-36, management, as a rule, exercised more care in the treatment of technical men and made an effort to preserve research organizations. Management has come to the realization that research organizations are not built up in a day, that years are needed to select and train technical men, that research requires careful nurture, and that complete abandonment of research programs with the dismissal of highly trained men, on the plea of financial necessity, is provocative of economic waste and is one of the surest ways to economic oblivion. On the other hand, research men of ability are wary of affiliating with a company which has an unstable research policy and which deals in wholesale slaughter of personnel during dark days of economic stress.

Safe Conditions for Working With Carbon Tetrachloride

Excerpts from a report of an investigation made by Drs. Henry Field Smyth, Henry F. Smyth, Jr., and Charles P. Carpenter of the Laboratory of Hygiene, Philadelphia, and sponsored by Diamond Alkali Co., Dow Chemical Co., Niagara Smelting Corp., Pennsylvania Salt Manufacturing Co., and Westvaco Chlorine Products, Inc.

CARBON tetrachloride has been available in commercial quantities for more than 30 years and its substitution for flammable solvents has eliminated fire hazard in many processes. Because of its low cost it is the most widely used chlorinated solvent in many operations where workmen are daily exposed to its vapors.

This investigation was undertaken to obtain experimental and clinical evidence on which to establish a safe concentration for carbon tetrachloride vapors in work rooms where men are continuously exposed. Animal experiment, measurement of vapor concentrations in industry, and physical examination of exposed workmen were included.

Animal experiments were conducted with groups of 24 guinea pigs, 24 albino rats, and 4 monkeys. Exposures lasted eight hours a day, five days a week, for a total of ten and one-half months, some of the animals receiving 225 exposures.

The carbon tetrachloride used was a chemically pure grade, by analysis less than 0.003 per cent carbon disulphide. It is of interest to note that the usual commercial grades are quite pure, having ordinarily less than 0.2 per cent foreign material, chiefly carbon disulphide, far too little to influence the toxicity of the vapors.

Vapor-air mixtures were prepared by bubbling measured streams of air through the solvent maintained at constant temperature, and subsequently diluting with streams of pure air. The mixtures were admitted to the exposure chambers at rates to give at least ten air changes an hour. The vapor-air streams were analyzed for carbon tetrachloride content, after removing water vapor and carbon dioxide by appropriate absorbents, by a specially made thermal conductivity cell. This cell had a sensitivity of approximately 1 p.p.m. (part per million) of the vapors. It was calibrated against similar vapor-air streams which were simultaneously analyzed by charcoal absorption, and by a thermal decomposition method. The air supply was a rotary pump drawing outdoor air from a point remote from contamination, and furnishing air free from all oil.

For measurement of carbon tetrachloride vapor concentration in establishments using the solvent and manufacturing it, a 50 centimeter portable Zeiss interference refractometer was used. This was calibrated in terms of refractive index difference per scale division. The sensitivity of the instrument was found to be 21.6 p.p.m. per scale division.

On the basis of animal experiments, it is concluded that 100 p.p.m. carbon tetrachloride vapor is a safe concentration for continuous exposure of workmen throughout the day, and day after day. It is believed that 1,000 p.p.m. is safe for periods up to half an hour a day with lower concentrations the rest of the day, provided the day's average does not exceed 100 p.p.m.

Carbon tetrachloride vapors of 100 p.p.m. are noticed by most people coming into the atmosphere from one free from carbon tetrachloride as a barely perceptible characteristic odor and particularly sensitive noses will detect 50 p.p.m. If the average nose recognizes more than a faint odor of the solvent on entering the work rooms, an increase in ventilation is called for.

It is definitely shown that an animal continuously exposed to amounts of carbon tetrachloride from 50 to 400 p.p.m. soon regenerates originally damaged liver cells and somewhat later regenerates damaged kidney cells while the exposure continues, the regenerated cells being more resistant than the original cells. It is believed on the basis of physical examination of workmen that the same is true of men. It is argued from this that in most cases men working with carbon tetrachloride under reasonable conditions of ventilation and care increase their resistance rather than increase their susceptibility.

Of the 96 men exposed to carbon tetrachloride in industry, who were studied in this investigation, tests showed no one who could be considered seriously or even unmistakably injured by the solvent vapors. Nineteen of these men had worked over ten years with the solvent, one of them twenty-five years. Although no unmistakable clinical test has been found to determine whether or not a given worker is being injured by carbon tetrachloride in the earliest stages of this injury, it is believed that the series of tests which has been suggested will establish strong probabilities, and for this reason a program of physical examination of exposed workmen is suggested. This program would protect men from more than the first stages of carbon tetrachloride injury, and men so detected do not have a progressive condition and hence will return completely to normal when their exposure is stopped. In most cases, such men will attain added resistance by regeneration of injured cells during a short rest from exposure, although occasional men probably will be found who cannot work with the solvent.

No worker need be injured by carbon tetrachloride exposure if intelligent planning and supervision are available, and if physical examination follows the schedule outlined. It is practical to use the solvent for any reasonable industrial operation without exceeding a concentration of 100 p.p.m. Standard dry cleaning machinery now available will keep the concentration below this figure, and by provisions of adequate exhaust ventilation other processes can be similarly guarded, usually without undue expense and perhaps with a saving of solvent.

Removing a coated plating rack from the Korolac dipping tank

A Protective Coating For Plating Racks

By H. E. FRITZ and G. R. MILLIGAN
The B. F. Goodrich Co., Akron, Ohio

THE PURPOSE in coating plating racks is to prevent the deposition of metal on the racks which is accompanied by loss of electrical energy, loss in the value of the metal deposited upon the rack, except as scrap, and frequently inferior plating due to fluctuation in current density. The electroplating industry for years has been seeking a suitable coating for racks which might be applied in its own plants and which would give satisfactory service when used in various plating and cleaning solutions.

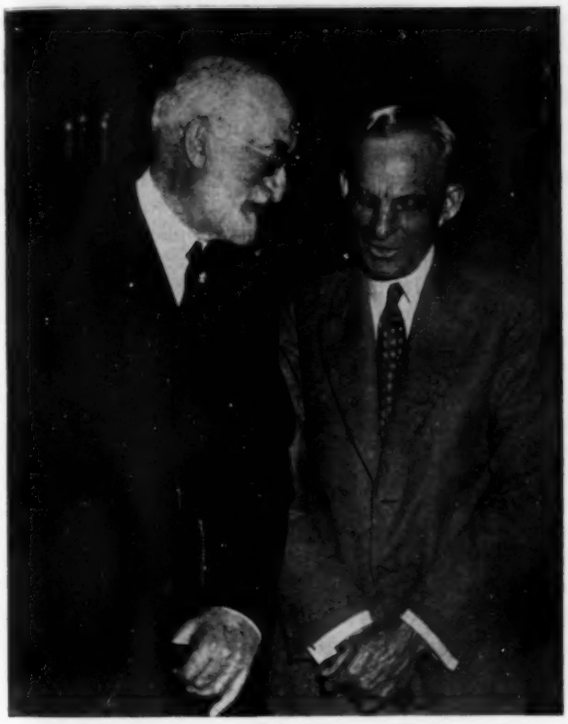
After extensive laboratory and factory tests, a synthetic flexible material, developed by The B. F. Goodrich Co, under the trade name of Korolac, was introduced to the electroplating industry in April, 1935. Since that time, a large number of installations have been made throughout the industry. This material is supplied in the form of a firm jelly which must be heated to approximately 195 deg. F. before it melts to a viscous liquid. It then remains sufficiently fluid between the temperatures of 175 to 200 deg. F. to permit racks to be coated by immersing in the Korolac. The dry film is resistant to practically all acids, alkalis and other solutions (at temperatures not over 220 deg. F.) used in the plating industry. Unlike rubber and lacquer coatings, the new coating is not affected by chrome plating solutions. It is being applied on racks in all types of plating work and has not been found to contaminate solutions, even those used in chromium and silver plating.

Korolac is an electrical and heat insulator which has no adhesion to other materials but holds its position on the rack because it shrinks considerably upon cooling and drying. This shrinkage causes sufficient tension so that plating solutions cannot creep back under the film at the exposed edges near the contacts.

The length of service received from racks covered with this material does not depend upon the chemical disintegration of the film alone. The amount of physical abuse which the racks receive and the temperature to which they are submitted has a most definite bearing on the life of the coating. Racks which are carelessly handled will last until breaks occur in the film, but when carefully handled long and satisfactory life can be expected. Excessive temperatures (above 220 deg. F.) tend to embrittle the coating. It has been found that racks may be covered with Korolac so that they will withstand severe abuse by giving them two dips in the molten material, then wrapping with an untreated cotton tape. The tape is impregnated by immersing in the bath for one or two minutes. One or more additional coats of Korolac are then applied over the wrapping by dipping. Even where rack coatings have been previously employed, users of the special material have reported that their electrical consumption has been reduced as much as 40 per cent with the result that expansion of production is possible without further capital expenditures for generating equipment. The coating eliminates "treeing" or depositing of metal upon the rack and therefore makes for worthwhile savings by preventing loss of metal from plating solutions which would have to be recovered from the rack or sold as scrap. In many cases its use has improved the quality of the plating. Due to long life of the coating and the ease of making repairs, appreciable savings have been made through lower maintenance costs. Users also claim that they are now able to make types of racks which they could not use before and can plate certain objects heretofore considered an impossibility.

The use of Korolac minimizes carry-over and staining which makes for further savings by reducing rejects and replacements to a negligible figure. It has also been possible to dispense with re-racking between nickel and chrome plating.

This new and satisfactory method of covering plating racks promotes improved operation and reduces rack covering costs. The material can be applied in a plating plant by reasonably intelligent workmen. The investment required depends upon the size of the racks to be covered but where a large number of racks are used, the cost is relatively low.



Heber J. Grant, Mormon Church president and pioneer beet sugar manufacturer, compares notes with Henry Ford at Second Dearborn Conference

Power Alcohol Controversy Gives Way To Broader Chemurgic* Program

EDITORIAL STAFF REPORT

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MOST of the 600 or more chemists and engineers, farmers and industrial executives who went to Detroit, May 12, for the second Dearborn Conference of the Farm Chemurgic Council expected to see a scrap over power alcohol. There had been a preliminary clash a month before at the Kansas City sessions of the Petroleum Division of the American Chemical Society, where diametrically opposed views had been expressed with some vehemence. And there were ugly rumors that prior discussion had been suppressed.

In the face of this apparent opposition on the part of the oil industry, the Chemical Foundation, Inc., which has sponsored the Council's program of cooperation of science and industry with agriculture, went ahead with its plans to lend financial support to the farm alcohol plant now under construction at Atchison, Kans. So the stage was all set for the battle and chemistry's eloquent champion, Mr. Garvan, was prepared to make the speech of his life. He did. For more than two hours he was roundly applauded as he turned his oratorical guns on the iniquitous oil industry. But the fire was not returned, immediately at least, for the program went calmly on and it was not until an adjourned session that the lone representative of the petroleum industry, Fred A. Eldean, young assistant to the president of the American Petroleum Institute, got in his valiant rebuttal. By that time it was apparent to all, however, that the Farm Chemurgic program was something much bigger and broader than any narrow controversy over alcohol for motor fuels. It encompassed the whole range of industrial products and processes dependent upon agricultural raw materials—from soybeans and oat hulls for plastics and cotton for rayon and roads to such new crops as oak trees for cork, Jerusalem artichokes for alcohol and pyretheum flowers for insecticides. More than 60 papers were sandwiched into three busy days of active discussion.

But power alcohol should not be dismissed quite so briefly. Mr. Garvan had made the point that we are using up our oil reserves at a rate which will mean exhaustion in 12 or 13 years, with no provision for increased consumption or war needs in case of an emergency. He accused the oil industry of opposing the use of alcohol in order to dispose of its vast holdings of foreign oils. After that is accomplished, according to Mr. Garvan's view, the German I.G. and their American associates, have arranged to monopolize control through the hydrogenation process. But by far his most telling arguments for power alcohol were a series of advertisements of American-owned companies in England and the Philippines, promoting the use of much higher blends of alcohol and gasoline than have been suggested in this country. If the 33⅓ per cent alcohol fuel marketed in England by American affiliates of the Standard Oil Co. of New Jersey and the Cities Service Co. were adopted in this country, it would mean the putting of 90,000,000 acres and 6,000,000 unemployed back to work. England,

*Chemurgy from the Greek roots for chemistry and work was originally defined by the eminent neomymologist, Dr. William J. Hale, as "the science concerned in the working with and for chemical compounds." (See *Chem. & Met.*, Nov. 1934, p. 567.) Today its most popular application is to the production of chemicals from agricultural raw materials.—Editor.

he said, had just as large foreign holdings of oil as we have, but she knows enough to conserve a great national resource to her own best interest.

William W. Buffum, general manager of the Chemical Foundation, Inc., revealed the real facts about that organization's financial connection with the power alcohol program. When it became evident that this project was not going to get started without some outside support, the Foundation selected the Bailor Manufacturing Co. of Atchison, Kans., for its experiment, hired the services of engineers to make a survey, and found that $116,000 of new equipment was necessary to produce the requisite quantity of anhydrous alcohol (10,000 gal. per day). A contract was drawn and signed whereby the Chemical Foundation made a loan of the money and agreed to take over (through a newly organized subsidiary, Chemical Foundation of Kansas) the entire output of the plant at cost plus 2 cents per gallon. Corn is to be purchased at the market. All costs are to be determined by a reliable firm of certified public accountants and made available to anyone. "This is to be a research, demonstration plant," said Mr. Buffum, "and we want no governmental subsidy, no tax exemption, no financial help from anybody but plenty of cooperation from everybody!"

Dr. Benjamin T. Brooks, consulting chemical engineer of New York, spoke of a threatened shortage in our supply of liquid fuel, citing many of the recent trends that he had previously reviewed in *Chem. & Met.* (Jan., 1936, pp. 10-13) and elsewhere. When Mr. Eldean finally got in his chance for rebuttal, he attempted to confute Dr. Brooks by reading from a recent report of a committee of ex-presidents of the American Society of Petroleum Geologists, that indicated a 25-year reserve, not including supplies recoverable from old wells. "Alarmists," he said, "have been predicting exhaustion of our petroleum stores periodically since 1889—and in eleven consecutive official reports, each has had to increase the estimates of earlier ones."

According to Mr. Eldean, the petroleum industry is not opposed to alcohol blended fuels as such, but it will vigorously oppose any effort to make their use compulsory. "Under the operation of normal economic laws, the public is entitled to and will ultimately obtain, the most efficient product for the particular use at the lowest possible price." He held that the oil industry recognizes its stewardship to serve the fuel demands of the nation and "if alcohol as a motor fuel has the qualities claimed for it and can be sold at economic prices, then the obvious thing to do is to go out and market it." A resolution proposed by Mr. Eldean would have had the Conference go on record "affirming its faith in fundamental research in harmony with fundamental economic laws and deprecating attempts to achieve the ends of industrial use of farm products through artificial action which looks toward compulsion direct or indirect by legislative enactment." No action was taken by the meeting except to refer the resolution to the Council which meets in New York this month.

A sidelight on the automobile manufacturer's attitude was reflected in the statement of Floyd F. Kishline, chief engineer of Graham-Paige Motors Corp., who said that "when the time comes that alcohol offers the best fuel, then we engineers must overcome our natural inclination to let well enough alone and help out this program without prejudice.

A chemical engineer, proud of his agricultural antecedence and early years on a Kansas farm, is Professor Arthur W. Hixson of Columbia University. He did not hesitate to make his diagnosis of farm ills and then to pronounce his remedy. Agriculture, he said, had changed from an independent, profitable, self-sufficient, economic unit in 1914 to a dependent, unprofitable unit today. One of the reasons often overlooked is the loss of the power market which prior to 1914 was supplied by horses and mules raised on the farm. A decrease of 10,000,000 horses from 1919 to 1929 meant a tremendous loss in the market for grain and in the return of organic nitrogen to the soil. It was also a great incidental source of revenue. If alcohol from corn would help the farmer to regain even a small part of the power market, Professor Hixson thinks he is entitled to it. But the best long time remedy he prescribed is a complete reorganization of agricultural research by staffing the experiment stations with research chemists and chemical engineers from industry who will give agriculture a new vision.

Many more eloquent apostles of research were on hand to endorse the prescription. Dr. Charles M. A. Stine, vice president of duPont, had said "Chemical research can change old resources to new industries. Exactly the same kind of fundamental and applied research as has long been used by industry, is now required to develop new uses for farm products and to indicate new products to be grown on our farms for technological use; in other words, research to enlarge and diversify our agricultural industry." Dr. E. R. Weidlein of Mellon Institute showed how the stimulating influence of industrial research as first prescribed by the late Robert Kennedy Duncan had resulted in the recovery of many sick industries and contributed to the good health and prosperity of others. President E. C. Elliott of Purdue University, said that the Farm Chemurgic Council would succeed only as it stimulated human interests and activities along more scientific lines—a greater contribution by far than any purely materialistic advance. "That group which in this generation succeeds in cornering the larger share of individuals of superior ability and training will control the affairs of our civilization." David E. Ross of the Purdue Foundation foresaw failure for all unless we can do something in this country to utilize to the full the resourcefulness and inventiveness of the 3 per cent of our research-minded engineering students.

Farm Products in Industry

Potential uses of agricultural raw materials in industry have scarcely been touched, according to Dr. Charles L. Gabriel, vice president of Commercial Solvents Corp. His company alone can consume in one day the grain grown annually on a thousand acres of fertile soil. "This grain is not converted into foodstuffs of any kind. Rather the products made from it serve every industry—from ore refining to medicine." Morris Sayre, vice president of Corn Products Refining Co., reported that the present consumption of corn by eleven American companies amounts to about 60,000,000 bu. annually which is equivalent to the average yield from some 2,000,000 acres. But he also sounded a note of warning to the effect that this consumption had taken decades to develop and under no circumstances should the farmer be led to believe that industrial miracles would suddenly solve the problem of corn surpluses.

Soybean oil is, of course, one of the most publicized of chemurgic products, but again it seemed worthwhile to sound a note of warning about too optimistic estimates of immediate consumption in the paint and varnish industry. E. E. Ware, chief chemist of the Sherwin-Williams Co., pointed out that the paint industry as a whole uses only 8 per cent of the total domestic oil consumption and half of this is crushed from domestic seed. Nevertheless this 4 per cent represents the product from a million otherwise idle acres and releases for stock feed or plastics some 130,000,000 lb. of soybean meal. Accordingly, he said, "we must promote, encourage and cooperate in agricultural research toward the improvement of the drying and film forming characteristics of soybean oil without sacrifice of its superior qualities of permanent elasticity and color retention." Dr. Harry A. Gardner of the Institute of Paint & Varnish Research lent further encouragement to the American farmer as a producer of superior tung oil. Perilla and other new oil crops are showing progress in experimental plantings.

Progress in Plastics

When Mr. Henry Ford was asked by the writer as to what part of the Farm Chemurgic program appeared most promising to him, he said: "The plastics field is the greatest in the industrial world today. Some time I hope we may be able to grow an automobile. Certainly the farm will furnish most of the automobile body of the future." Definite progress in this direction as made by the Ford Motor Co. was effectively presented by R. A. Boyer of the Edison Institute at a symposium held under the chairmanship of Dr. Hale. (See article "How Soybean Helps Build Fords" by Robert L. Taylor, appearing in the April *Chem. & Met.*)

Williams Haynes of *Chemical Industries* showed how the output of the plastics industry had expanded even during the depression, from 70,000,000 lb. in 1929 to perhaps 106,000,000 lb. in 1935. Prices have been reduced to such an extent that he felt warranted in prophesying that some day we shall have a satisfactory synthetic plastic costing not more than four or five cents per lb. Harry Dent, president of General Plastics, told of experimental work his company has already done with exploded wood plastics costing less than one cent per lb. Not to be outdone in his favorite field of prophecy, the chairman ventured the statement that two-cent acetic acid and four-cent acetic anhydride were definitely in the offing—and when they arrived, we can look for tremendous progress in acetate plastics.

The lowly oat-hull, which for 15 years has given us our supply of furfural for plastics and the refining of rosin and lubricating oils, is not the only chemurgic product of this industry. Dr. F. N. Peters of Quaker Oats told of new oat flour products already widely used in the cosmetic industry and being promoted for use in foods where they show remarkable preservative properties in preventing rancidity in lard, potato chips and salted nuts, —even the smallest quantities being effective in preserving the aroma in coffee.

Professor H. K. Benson, in charge of chemical engineering at the University of Washington, cited several new industrial products being made from wood in the West. In one case saw-mill waste is shredded and stirred into a slurry of magnesia and sulphuric acid. The mineralized fibers thus produced are formed into panels or squares and used for wallboards. By use of high pressure briquetting machines sawdust is also being made into synthetic logs for fireplaces and open grate heaters. Pentosan plastics made experimentally from wood, HCl and phenol or cresol exhibit excellent insulation properties. Lignin, the chief organic constituent of waste sulphite liquor is finding use as a road binder, and tanning extracts have also been made from it.

A concluding thought: If the Farm Chemurgic program progresses as rapidly in the next few years as it has in the past one, we may be willing to take a little more seriously Dr. Hale's suggestion that the name of this magazine be changed to *"Chemurgical Engineering"!*

Government Promises Cooperation In Chemurgic Research

DEPARTMENT of Agriculture will cooperate with Farm Chemurgic Council in efforts to find new industrial uses for farm products, Secretary Henry A. Wallace said in a letter, made public May 27, to Francis P. Garvan, of Dearborn, Michigan, President of the Council.

Secretary Wallace's letter was in response to a letter from Mr. Garvan addressed to Dr. Henry G. Knight of the Bureau of Chemistry and Soils, dated Nov. 14, 1935, and outlining a proposed "Plan for Coordinating Industry, Agriculture and Science." No explanation was offered for the delayed response but keen observers in Washington sensed in it an attempt to capitalize politically on the important progress the movement is making in the Middle West.

Secretary Wallace said in his letter that the Department's present extensive work in this field is now being surveyed with a view to further expansion, and invited the Farm Chemurgic Council to recommend new research projects in addition to those which the Department is already carrying on. Secretary Wallace commended the Farm Chemurgic Council for its activities in this field.

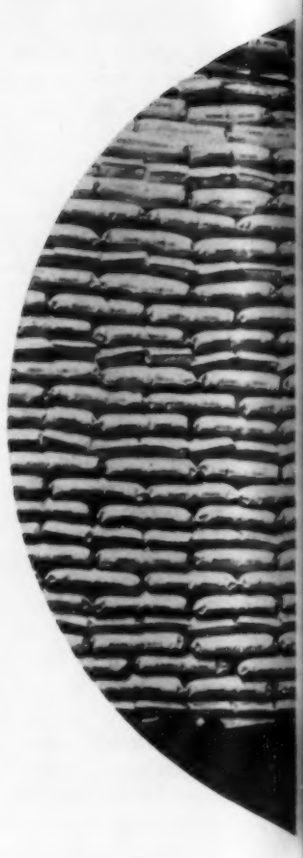
"I can say at the outset, then, that I am glad industry has now become more actively interested in this important part of our work and will give such hearty cooperation as your outline indicates. Such an organization as the Farm Chemurgic Council should be able to perform a genuine service in keeping industrialists informed of what public agencies are doing in this field and acting as a clearing house for ideas and a source of suggestions."

In his letter, Mr. Wallace laid special emphasis upon the Department of Agriculture's concern that to be of significant assistance to agriculture any new industrial outlets that may be opened for farm products must be "at a price that will be profitable to the farmers."

"Scientific research," he pointed out, "does not by any means tell the whole story. It must work hand in hand with hardheaded cost-accounting and commercial research. Although a product may be made perfectly in the laboratory, this does not say that it will necessarily be profitable to producers. The final step is the testing out under practical conditions on a commercial scale. In particular, of course, this Department's concern is that when the farmer supplies raw materials to industry, it must be at a price that will be profitable to the farmer."

"Economic statesmanship," Secretary Wallace said, "still is needed to solve the problems of agriculture."

By R. W. LAHEY
American Cyanamid Co.
New York, N. Y.



Chemicals Automatically Packed In Paper Bags

IN THE United States and Canada last year, almost 350,000,000 heavy-duty multi-wall paper bags were used for shipping a wide variety of products. These bags were used to transport almost 50 per cent of the cement and most of the hydrated lime packed in this country, as well as substantial amounts of gypsum plaster, fertilizer, calcium chloride, soda ash, etc. Not only were these containers used for domestic shipments, but many large export and import shipments were packed in them. As an example of this, the United Fruit Co. transports to their South American holdings large quantities of cement packed in paper bags. This material is shipped to the seaports by rail and then transferred to barges. Their steamers are loaded direct from the barges by means of slings. The cargo arrives at its destination with a negligible amount of breakage. For several years, many export and import shipments packed in paper bags have been handled through the port of New York, and interviews with the stevedore foremen and dock superintendents show conclusively that these containers stand rough handling satisfactorily—the resulting breakage being well under 1 per cent of the total.

Surely this is an imposing record and warrants the attention of all wide-awake shippers. This is particularly the case in the process industries, where so many powdered and granular products are packed and shipped. Paper has proved its worth as a bag material, as it has for drums, which were discussed in the April issue of *Chemical and Metallurgical Engineering*.

In the choice of a container for powdered and granular products the multi-wall paper bags should receive consideration. These containers can be so constructed that they will have adequate strength to withstand most transportation abuses. Multi-wall bags are made in two general types—the pre-closed or valve type, which requires automatic filling machinery, and the open mouth type, which can be filled and closed automatically or can be filled by existing equipment and closed with a sewing machine which contains special attachments.

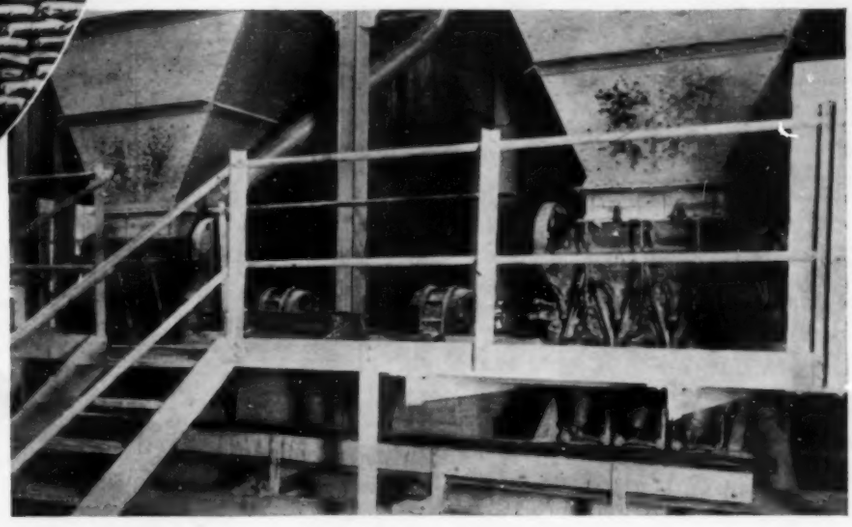
There are two fundamentals which must be considered before a detailed investigation of the suitability of paper bags and automatic packing is warranted. The first is to determine whether the desired packing rate is in line with the capacity of the available machines. The second is to be sure that the existing machines can handle the product in question. The physical and chemical properties of some materials do not permit automatic machine weighing and filling. If for either of these reasons it is impractical to use automatic machinery it is possible that the packing equipment in use could be adapted to filling paper bags. Then the devices for closing these sacks by sewing and taping should be investigated.

The use of paper bags as heavy-duty shipping containers has been closely related to the development of automatic bag filling machinery. For this reason, a discussion of the progress which has been made in the field of automatic packing is desirable for an understanding of the factors which have made possible the tremendous growth in the use of multi-wall paper bags.

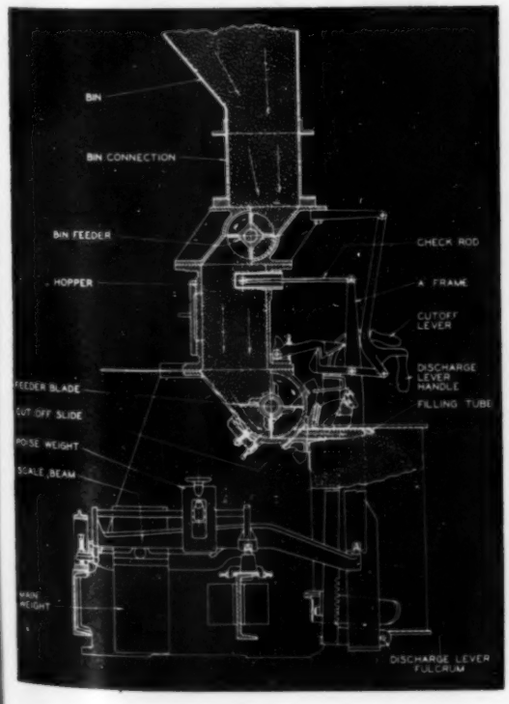
The bag filling methods in use in the early part of the century were extremely crude as compared with the highly efficient practices of today. Consider cement: Textile bags were held open by the prongs of an oversized bootjack while the cement was shoveled into the

container. The man handling the shovel guessed at the amount and then the bag was placed on a scale and the weight corrected by the "put-and-take" method. Finally, the bag was closed by tying with string. This resulted in a daily output for the shoveler of an average of 500 bags. Today, a man sits in front of a three-tube automatic packer and merely operates the machine, placing the empty bags on the filling tubes and releasing the filled bags so that they fall on a moving belt. He packs as much in one hour, with much less effort, as was formerly packed in a day.

This great progress in packing resulted from the ingenuity of the late A. M. Bates who, realizing the need for improved methods of packing, conceived the revolutionary idea of a pre-closed bag—a bag closed at both ends save for a small opening or "valve" in one corner through which it is filled. The valve is so designed as to be self-closing due to the internal pressure of the contents as the bag is withdrawn from the filling tube.

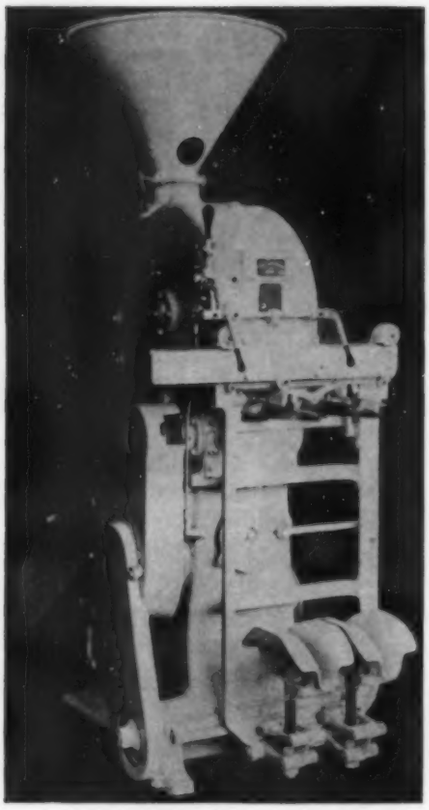


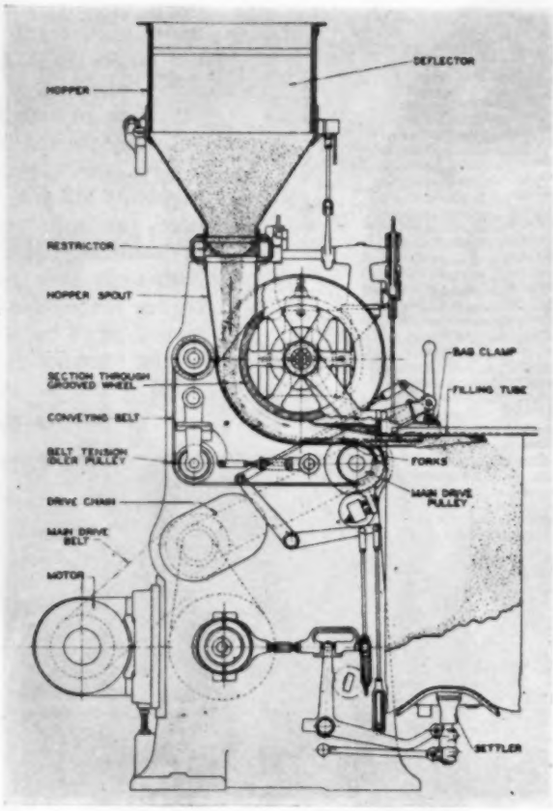
With a three-tube unit and belt conveyor (removing filled bags) one operator can pack from 700 to 900 bags of cement per hour, each bag containing 94 lb. This machine may be obtained with from one up to four tubes



The first machine developed by Bates was found to be highly efficient for the packing of cement and certain other dry pulverized materials. The principles of the machines in use today in modern cement plants are essentially those incorporated in the early design. Here is a layman's brief description of the type of packing equipment now used in cement plants throughout the United States.

The material is conveyed to an overhead bin, from which it flows by gravity to a "bin feeder" which serves to regulate the rate at which the material is delivered to the "feeder blades" (see diagram). The vertical blades rotate constantly and, when the "cut-off slide" is open, working on the centrifugal pump principle, force the material through the filling tube into the bag. At the beginning of the filling cycle the empty bag is slipped on the filling tube. The cut-off slide is opened and, as the bag fills, its weight is supported both by the filling tube from which it hangs and by the "bag chair" located beneath the bag. Both the filling tube and bag chair are mounted on a frame which, in turn, is mounted on a scale





A one-tube belt packer will fill from three to four 100-lb. bags per min.; a two-tube unit will fill twice this number. The power requirements are about 3 hp. per tube. They have proved successful in handling such products as sugar, poultry feed, calcium chloride and salt

beam. The weighing mechanism is so adjusted that when the contents in the bag has nearly reached the desired weight the frame moves downward carrying the filling tube with it. The upper portion of the filling tube support first restricts the flow and, as the frame completes its downward movement, completely closes the filling orifice so that the flow of cement is shut off. The filled bag is discharged from the filling tube by pulling a discharge lever which tilts the bag chair. The bag chair returns to its original position, the operator places an empty bag on the tube, and thus the cycle is repeated.

With a three-tube unit and belt conveyor (removing the filled bags) one operator can pack from 700 to 900 bags per hour, each bag containing 94 lb. The machine requires about 5 hp. per tube. These machines can be obtained in sizes ranging from one tube up to four tubes.

Previous to the development of such automatic bag-filling machinery, paper bags had been used as shipping containers, but only to a limited degree. These bags were of the single-wall, open-mouth type which, after filling, were tied with string or wire. The growth in the use of paper bags depended upon the perfection of a stronger container and one that was more convenient and economical to close. The solutions to these problems were found first by the development of the valve bag just described. It was quickly proved that this "factory-made" closure was considerably stronger and more serviceable than that of bags closed after filling by the use of wire ties or string.

For many years, single-wall paper bags of the valve type were used by both the cement and lime industries. The tremendous increase in the use of paper bags as heavy-duty packages began in 1924 with the development of the paper bag of multi-wall construction. Bags of this type were developed on the theory that a package constructed of a number of plies is stronger and more flexible than one constructed of a single ply of relatively thick paper. It was found that such bags had a carrying power far exceeding any paper bag then in use. The consumption of multi-wall paper bags increased so rapidly that, in 1935, in the United States and Canada alone, 75,000 tons of kraft paper were used in the manufacture of these sacks.

In order to bring about this huge increase in the use of multi-wall paper bags it was necessary to develop valve bag packing machines which would handle a wide variety of products. The type of machine used for cement and lime was found unsuitable for the handling of all types of pulverized and granular materials mainly because of the grinding effect as well as the heat developoped by the constantly rotating impeller. Therefore, a modified machine was designed in which the impeller rotated only during the time the bag was being filled. This was accomplished by mounting each impeller on an

independent shaft and using a clutch and brake mechanism to start and stop the impeller rotation.

Machines of this type have a maximum output of from five 100-lb. bags per min. for a machine having one filling tube and requiring from 8 to 10 hp. up to ten or twelve 100-lb. bags per min. with a two-tube machine which, depending upon the characteristics of the material being packed, may require up to 40 hp. Machines of this type are used for a wide variety of materials, including soda ash, pigments and bicarbonate of soda.

The "start-and-stop" impeller principle overcame many of the difficulties encountered in adapting the cement packer to the handling of other commodities. However, for some products, particularly those of the granular type, the impeller principle of packing was still found to be unsuitable.

Efforts to overcome the problems led to the developments of the so-called belt packer. Although these machines have been in use for only a few years they have proved successful in handling such products as sugar, poultry feed, calcium chloride and salt.

The principle of this machine represents a striking divergence from the impeller packer. In the first place, the charge is pre-weighed rather than weighed as packed; the machine being designed so that it may be used in conjunction with any of the standard automatic scales now on the market. The charge of material is fed by gravity through a restricted opening which leads to a spout carefully fitted to a large grooved wheel (see diagram). An endless flat belt running around the lower quarter of this wheel confines the product to the groove as the material is rotated so that its direction of flow is changed from vertical to horizontal. The rate of flow is greatly accelerated by the combination of centrifugal force and belt speed and the material is literally thrown through the filling tube into the bag. The bag chair of this machine is equipped with a vibrating device which permits the bag to be tightly and uniformly packed.

A one-tube belt packer will fill from three to four 100-lb. bags per min.; a two-tube unit will fill twice this number. The power requirements are about 3 hp. per tube.

Recently, there has been developed a packer which, while utilizing the filling principles of the belt packer, weighs the bag as it is being filled rather than using a pre-weighed charge. Such machines are now being used for mixed fertilizers, superphosphate and other products.

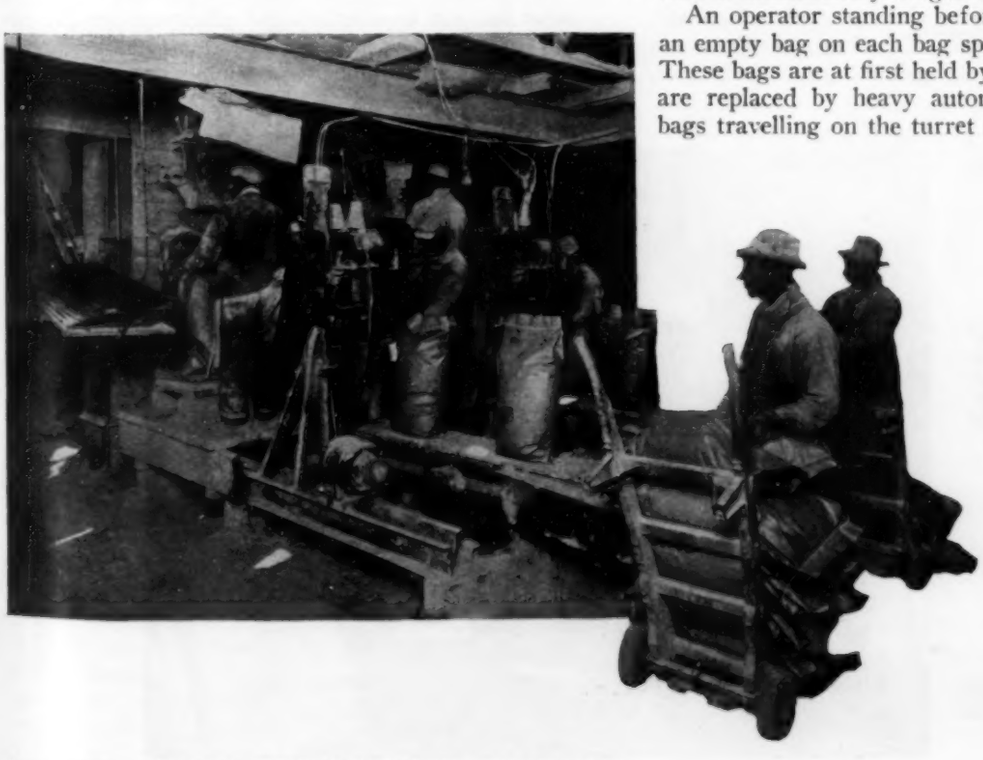
Another type of packer using the pre-weighing principle has been developed for such products as flour, bran, calsomine and starch. The weighed charge drops to a tapered screw conveyor which compresses the material slightly and forces it through the filling tube into the bag. The bag chair of this machine is also equipped with a settling device. For a powdered material which is easily aerated the impeller type of packer has a disadvantage in that it forces a certain amount of air into the bag which must be allowed to escape before the bag can be compactly filled. The packer using the screw conveyor system of filling overcomes this difficulty.

Many years of development work have been spent in producing valve bag packing machines capable of handling a great range of products and also in improving and bettering the pre-closed bag. This work has resulted in better closing of the valves and in complete freedom from sifting at the valve corner by the use of the so-called tuck-in sleeve.

Working on a contrasting theory that the bag should not be closed until after it has been filled, one company devised a sewing head adapted for closing paper bags in the field. They have applied this same principle to a combination automatic packing and closing machine.

This apparatus consists of a revolving turret containing six or eight bag spouts depending on the quantity of material to be packed. Located near the top of the machine are two or three Hoepner scales. The material flows by gravity or is conveyed to the scales where each load is automatically weighed in advance.

An operator standing before the revolving turret slips an empty bag on each bag spout as it passes before him. These bags are at first held by spring clips, but later they are replaced by heavy automatic grippers. As empty bags travelling on the turret arrive under the scale hop-



Two bag closing units are used in conjunction with the regular bag filling equipment to close paper sacks by sewing. Note that in this case tape is not used in the closure

pers, lugs on the turret cause the hopper to dump a full charge into each bag as it passes. Should the operator fail to place a bag on any spout, the dumping of a charge in this spout is automatically prevented.

As the turret continues to revolve, the bags are gradually lowered until they rest on a roller conveyor, which is vibrated vertically, thereby settling the load in the bag. As the bags approach the point where they have almost completed the circle of the turret they have been lowered completely under the spouts and the grippers have brought the walls of the bag at the mouth together. Here the top of the bag passes between two chains moving in a direction which is tangential to the direction in which the turret is traveling. At this point the grippers automatically release the bag to its new carrier. The bag is carried on a slat conveyor, the speed of which has been synchronized with the chains.

This straightaway portion of the machine is the continuously moving closing unit on which the bags are spaced about three inches apart. The bag tops which project above the carrying chains, first pass through a safety device which stops the machine if the bag mouth is not in proper position for sewing. The bags then pass through the sewing head where they are sewed with the cushion stitch. They are then taped with creped kraft paper over the sewing by passing through a device which folds the tape over the bag top, applies latex, and pressure is brought to bear on the tape by two pair of rollers. Tape and thread between bags are cut and they are then ready to be removed to the freight car or to storage by conveyor, hand truck or other means. This machine will pack and close 100-lb. paper bags at the rate of 30 to 45 tons per hr.

The paper bag closing unit alone has proved to be a handy apparatus as it can be combined with any type of filling machinery in use. It may be necessary to change the spout on the bag hopper and add grippers for convenient filling of the paper bags. This closing unit is similar to the standard textile bag closing units including a conveyor to carry the bag through the sewing machine. This sewing head applies a reinforced stitch which will not pull through the paper walls of the bag and then a tape is applied over the sewing using latex for the adhesive. Machines can be obtained without this taping equipment.

Another bag company has devised a handy attachment for applying tape immediately before sewing a paper bag and it can be used in conjunction with the regular bag sewing machines. This machine is similar to the one just described except that the bag is sewed through the tape. This latter method is one in use for sewing the tops and bottoms of pre-closed bags.

This array of machinery gives the shipper a liberal choice and it is almost certain that some combination of equipment can be obtained which will prove practical and economical. Even if no automatic filling and weighing machine can be found to handle a product the present equipment can be used for filling paper bags with the addition of a bag closing unit.

Usually it is less expensive to store the product in bulk and pack it immediately before shipping. This provides the obvious economy of requiring only one handling of the product in containers. Most of the rock products and fertilizer which is packed in paper bags is handled in this manner. The equipment described can be used efficiently for packing products as produced if it is found necessary to store the product in containers. Paper bags can be piled to any practical height without damage, as can be noted in an accompanying photograph. There are several methods of handling the sacks.

This covers in a general way the filling, weighing and closing of paper sacks. Of equal importance is the container itself. There is no question but that the heavy-duty, multi-wall paper bags can be constructed to provide containers which are outstanding in ruggedness, strength, prevention of contamination and resistance to the transmission of water vapor. All of these points will be discussed in an early issue of *Chemical and Metallurgical Engineering*.

In the so-called small or retail package field, equipment can be obtained which will take a product from the final production stage and almost automatically place it into its shipping container. The handling and packing of the bulk container has not approached this efficiency, but the machinery just described indicates that at last bulk packaging is receiving the attention of the equipment manufacturers.

Automatic packing and closing machine. The revolving turret fills and the device to the left automatically closes the bags

Manufacturing Gas Industry's Problems Discussed

EDITORIAL STAFF REPORT

THE JOINT CONFERENCE of the production and chemical committees of the American Gas Association was held in New York, May 25 to 27. In addition to the reports and papers that were presented several informal luncheon conferences were held which provided a further opportunity to exchange experiences and ideas on a wide variety of subjects connected with the manufactured gas industry.

The nitrogenous-gum problem was discussed in a paper by W. L. Shively and E. V. Harlow of the Koppers Construction Co. A process of affecting nitric-oxide elimination and commensurate reduction of the gum-forming tendency of the gas involving treatment of the gas with an electrical brush discharge has been discovered and reduced to practice. An installation incorporating this principle, having a capacity of 24,000,000 cu.ft. gas per day, was made at the Philadelphia Coke Co. This apparatus has been in operation since Aug. 30, 1935, and has shown a nitric-oxide elimination of from 97 to 98 per cent. Little operating attention is required, and the costs (including fixed charges) are 0.152 cents per M cu.ft. of gas treated. The equipment also has other applications which are now being investigated.

Gum Difficulties

Plant experiences in the practical reduction of gum difficulties, vapor or liquid were reported by William K. Beard of the Philadelphia Gas Works Co. A table was compiled showing the relationship between the type of gas, the number of stoppages, and the causes assigned. The practical means of reducing stoppages, particularly where gums are blamed, are quite varied and were outlined separately. The reduction of stoppage difficulties as practiced by the companies contributing data for this report is attained by:

1. Retarding gum formation in the process of manufacturing the gas.
2. Removing gums after formation
3. Combinations of (1) and (2)
4. Minimizing the effects of dust, rust, etc.

Examination of the table reveals that vapor phase gum is as prevalent and as detrimental in a carburetted water gas as liquid phase gum; contrary to the general belief. Liquid phase gum appears only in carburetted water gas while the only gums in coal gas are those formed in the vapor phase.

Cost of Nitric-Oxide Elimination Koppers Treater: Philadelphia Coke Co.

(Capacity of Plant 24,000,000 cu. ft. per day)

			Per Day
Fixed Charges			
Power	Production of brush discharge: 20 watt-hours per M cu. ft. gas at 1¢ per kw.-hr. $\frac{24{,}000 \times 20 \times 1¢}{1{,}000}$	= $4.80	
	For oil-spray pump 12 hw. kr. at 1¢ per kw. hr.	= 0.12	4.92
Maintenance	Painting of shells, cleaning of insulators and electrodes, replacement of pins, etc.; estimated at:		5.00
Labor	NO tests, inspection, etc.		2.00
Steam	For heating insulator compartments 2500 lb. at 25¢ per M lb $\frac{2{,}500}{1{,}000} \times 25¢$		0.63
Total			$36.55
	Cost per M cu. ft. of gas treated: $\frac{3{,}655}{24{,}000} = 0.152¢$		

For some time it has been believed that a need existed for a simple outline which would enable one to estimate with almost quantitative certainty the various oil, mineral and gum components found in the agglomerations so common to gas distribution networks. To meet this need a method has been developed. It was discussed in a paper by Alfred R. Bayer of the Brooklyn Union Gas Co. The deposit components are termed moisture, light oil, heavy oil, soluble mineral and insoluble residue fractions. The steps in the procedure for the separation of each fraction was discussed by the speaker.

Complete removal of hydrogen sulphide from gas by the two-stage Thylox process was the subject of a paper by A. R. Powell of the Koppers Construction Co. Results of the operation of this process at the Belle, W. Va., plant of E. I. duPont de Nemours & Co. is reported elsewhere in this issue of *Chemical & Metallurgical Engineering*.

A report of the progress on the various methods for the removal of free sulphur from spent oxide, with special reference to removal by solvent extraction was given by E. L. Sweeney and A. E. Sands of the Boston Consolidated Gas Co.

Among the conclusions are the following:

1. Several relatively inexpensive solvents were studied to determine their value for use in the extraction of sulphur from spent oxide. Sulphur appears to be miscible with liquid naphthalene in all proportions at 250 deg. F.

2. Small scale laboratory experiments indicate that substantially complete recovery of the free sulphur can be effected by means of solvent extraction, to yield a sulphur product of high purity.

3. Fouling tests on the extracted oxide prove that it has a value for purification nearly as great as the new oxide.

4. Fouling tests by the Seil method favor more active oxides because of the high space velocity employed. By this test, a less active oxide may be shown to be incapable of giving complete removal of hydrogen sulphide, but upon reducing the space velocity results for a highly active, and less active, oxides may be nearly equal.

Recovery of Free Sulphur

5. Continuation of work on the recovery of free sulphur from spent oxide by extraction is recommended and a summary of the principal points of attack is presented here.

Retarding gum formation while manufacturing the gas is effected by:

I. Controlling the production of nitric oxide, and hence the vapor phase gum, by keeping out the products of combustion. The products are usually the result of:

(1) Poor generator fuel bed conditions in water gas sets allowing secondary combustion from the "blast purge" and "blow run."

(2) Inadequate purging of water gas sets. It may be necessary to purge with steam or blue gas after the blast; but if fire conditions are good, cutting off secondary air sufficiently ahead of primary air at the end of the blasting period should suffice.

(3) Incorrect pressure gradient between ovens or retorts and heating flues in coal gas apparatus.

(4) Air being drawn into coke ovens while charging as the result of poorly regulated steam charging syphons.

II. Controlling the production of liquid phase gum in carburetted water gas by preventing the formation of indene and styrene. This may be done by:

(1) Raising the operating temperatures in the carburetor and superheater.

(2) Increasing the number of checker bricks in the carburetor.

(3) Improving the dispersion or atomization of the oil admitted to the carburetor.

Removing the gums made during the manufacture of the gas is accomplished to a considerable extent through—

I. Eliminating the nitric oxide and vapor phase gum by—

(1) Aging the gas in holders.

(2) Keeping air out of the gas; particularly air for dilution of coal gas.

(3) Operating oxide purifiers:

(a) Without revivification air or with a reduced amount of air.

(b) With single fouled oxide.

(c) With well sulphided oxide beds placed first in series.

(d) With box containing freshly revivified material placed in middle of series—not first or last.

(e) With constant alkalinity.

(4) Compressing the gas.

(5) Fogging the gas with oil or oil containing gum inhibitors.

(6) Specially designed removal apparatus.

II. Eliminating the liquid phase gum by—

(1) Condensing.

(2) Injecting Tetralin at storage holder inlet. (This has lately been tried at the rate of two gallons of Tetralin per M² cu.ft. The results are not as yet available for publication.)

(3) More adequate tar vapor removal apparatus including—

(a) Tar extractors.

(b) Tar precipitators.

(c) Purifier catch boxes.

III. The effects of dust may be minimized by—

(1) Humidification of the gas leaving storage holders (steaming).

(2) Decreasing velocities in transmission mains.

In recent years such a vast amount of material has been published on the subject of heat transfer that the occasional student of the subject finds more confusion than information. Prof. C. C. Furnas reviewed and formulated the high points and principles of heat transfer for the use of the person who hasn't time to dig into the details of the subject.

Corrosive Action of Salt Water

Experience with corrosive action of salt water when used for cooling at the Harrison plant of the Public Service Electric and Gas Co. was discussed by E. M. Bliss. He concluded that there is a lot of valuable information in the literature on corrosion which ought to enable engineers to avoid many pitfalls. Of course, for specific problems it is always best when time is available to make tests under the actual condition. And when using dissimilar metals in salt water, insulate them from each other or at least pick those with low differences in potential and keep the exposed surfaces of the more mobile metal to a minimum in order to reduce the corrosion.

Under present conditions when every coke plant operator is attempting to reduce operating expenses and to obtain a maximum coke credit any means of increasing the value of coke breeze is of considerable interest. One possible means of accomplishing this is to convert at least part of the breeze into salable coke by mixing with the coal prior to carbonization. The effect of addition of coke breeze to coal on the strength and structure of coke was reported by F. J. Pfluke of the Rochester Gas and Electric Corp. The opinion was expressed that at least with certain kinds of either blended or 100 per cent high volatile coal certain amounts of coke breeze may be disposed of by mixing with the coal to be carbonized. The addition of this breeze does not produce harmful effects on the coke strength providing the size of the breeze is kept below certain limits. Under the same conditions the size of the coke on the wharf is materially increased.

McCabe-Thiele Diagram Useful in Extraction Problems

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EARLY IN 1929, H. Guinot (*Chemie et Ind.*, **21**, No. 2) first pointed out the parallelism between the separation of the two components of a mixed liquid by distillation and by extraction with a third liquid. Each process utilizes the change in proportion of the components effected by an outside factor. In the case of distillation, this factor is heat; in the case of extraction, the change is effected by a solvent. With the recognition of this relationship, it was realized that in principle, any graphical method useful for distillation could be applied to extraction. Guinot (*ibid.*) found that by assuming a constant distribution coefficient, the method of Savarit was useful, while several investigators have found the method of Ponchon suitable (E. W. Thiele, *Ind. Eng. Chem.*, **27**, 1935, p. 392). No one, however, has developed the analogy for the method of McCabe and Thiele, which is the simplest and most accurate treatment for distillation problems. The purpose of this paper is to develop the method of McCabe and Thiele for the functioning of a battery of extraction units.

Although distillation and extraction have many general aspects in common, there are a few fundamental principles concerning the phenomena of separation existing at the time of extraction which must be understood before treating the problem mathematically. Probably the best known liquid extraction process is that of separating acetic acid from dilute aqueous solutions. This system, therefore, will be considered representative and used as a basis for illustration. The effect of temperature on solubility is well known, but since cold extraction processes presuppose room temperature operation, this factor will be considered constant throughout all manipulations.

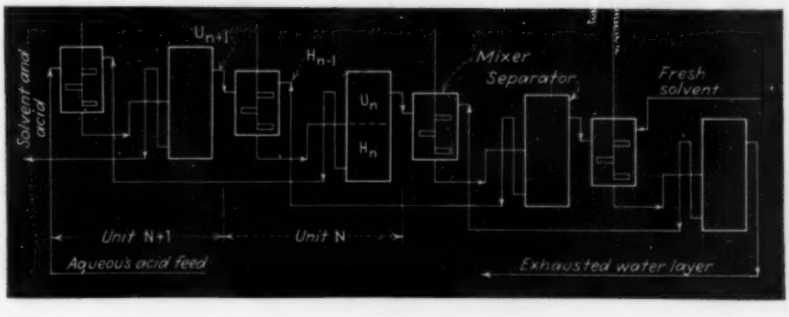
When an aqueous acetic acid solution is agitated with a liquid which is insoluble, or only very slightly soluble in water, the latter dissolves a quantity of acid depending on the content of the aqueous layer at equilibrium. That is, after sufficient agitation to attain equilibrium, the proportion of acetic acid which will have been extracted from aqueous solution will be different for unlike original aqueous solution compositions. This leads directly to the concept of distribution coefficient, which is the value of the ratio between the acidity of the solvent layer and that of the aqueous layer at equilibrium. This value does not remain constant but varies with aqueous layer acidity as is well illustrated by the recent work of Smith and Elgin (*J. Phys. Chem.*, **39**, 1935, p. 1149) who show that the distribution of acetic acid between water and isopropyl ether changes from a ratio of 0.19 to 0.25 as the acid concentration in the water layer increases from 0.3 to 2.8 mols per liter. It is obvious that the greater the value of the distribution coefficient effected by the solvent chosen, the fewer the number of extraction units will be required.

The usefulness of a solvent also depends upon a second consideration. This deals with the quantity of water extracted along with acetic acid from the aqueous layer. The solvents which may be added will vary in the quantity of water which they will extract per mol of acid. Hence, although a solvent may give a large distribution coefficient, the acid in the solvent layer may be highly hydrated, in which case weak rather than strong acid will be extracted.

One further fundamental must be considered as underlying any efficient cold extraction process which is run countercurrently. This lies in the fact, as pointed out by Suida (*Oesterr. Chem. Ztg.*, 1927, p. 3) that a violent agitation of the solvent with the solution to be treated establishes distribution equilibrium almost instantaneously.

In Fig. 1 is shown a diagram of a countercurrent extraction battery composed of a series of mixers arranged, for convenience of illustration, in cascade form. Each mixer is connected with a separator, the function of which is to allow the liquids agitated in the mixer to stratify in order to send each of the two layers in the proper direction. At one end of the battery, the pure solvent enters and the aqueous layer with its acid extracted leaves. At the opposite end, the aqueous feed enters and the solvent containing the extracted acid

Fig. 1—Diagram of four-unit countercurrent extraction battery



leaves. In this diagram, the aqueous (upper) layer progresses by gravity while the solvent (lower) layer is moved by pumping. Thus the two layers move countercurrently.

The fresh feed of aqueous acetic acid entering the first extractor is agitated violently with the solvent layer coming from the second separator. After agitation, the mixture from the first extractor enters the first separator from which the solvent layer containing the extracted acetic acid leaves the system. The aqueous layer proceeds to the second extractor and so on to the final separator. In each unit some of the acid content is removed so that after leaving the final separator, this content is so small that the layer may be discarded.

It will be seen that the extraction units serve the same fractionating function in the battery as do plates in a rectifying column.

Development of McCabe-Thiele Analogy

With these fundamental considerations in mind, the mathematical analogy between fractionation and extraction may be carried forward directly using the McCabe-Thiele diagram method. Let H = total number of mols in heavy layer; U = total number of mols in upper layer; H_n = total number of mols in heavy layer of unit N; U_n = total number of mols in upper layer of unit N; H_{n-1} = total number of mols in heavy layer dropping to unit N; U_{n+1} = total number of mols in upper layer rising to unit N; A = component to be extracted; X = mol fraction of A in heavy layer; and Y = mol fraction of A in upper layer. The total material balance for extraction unit N becomes:

$$U_{n+1} + H_{n-1} = U_n + H_n \qquad (1)$$

and the component A balance for extraction unit N becomes:

$$(U_{n+1})(Y_{n+1}) + (H_{n-1})(X_{n-1}) = U_nY_n + H_n X_n \qquad (2)$$

If the number of mols in each layer were to remain unchanged in passage through the battery, U_{n+1} would equal U_n, and H_{n-1} would equal H_n or:

$$U_n(Y_{n+1}) + H_n(X_{n-1}) \text{ would equal } U_nY_n + H_nX_n \qquad (3)$$

or simplifying:

$$\frac{H_n}{U_n} \text{ would equal } \frac{Y_n - Y_{n+1}}{X_{n-1} - X_n} \qquad (4)$$

The number of mols in each layer changes in each extraction unit and, therefore, equation (4) cannot be true as it stands. This, however, is the fundamental equation necessary for the application of the McCabe-Thiele graphical analogy for the calculation of the required number of extraction units, and can, by means of a few simple operations, be made to represent the conditions existing within the battery.

Since each extraction unit has two layers in equilibrium, the total number of mols in each layer is always a function of the number of mols of component A in that layer. Consider $X_{n-1} - X_n$ as representing any small change in the mol fraction of component A in the heavy layer; then for this change, there must be a corresponding change $H_{n-1} - H_n$ in the total number of mols in the heavy layer, or, expressed mathematically:

$$dH = H\ d \text{ mols component } A \text{ in heavy layer} \qquad (5)$$

For the overall change in the total number of mols in the heavy layers throughout the battery, the total value of H will be the integral of this expression, integrated between the limits of mols A in the heavy layer of extraction unit No. 1, and mols A in the heavy layer of the final extraction unit. The average number of mols in the heavy layer (H_{av}) will then be the value of this integral divided by the numerical difference between the limits. The same reasoning may be applied to determine the average value of U for the battery. But, since the diffusion coefficient rarely remains constant in such a system, the change in the number of mols will not follow the distribution law and, hence, the above integration must be made graphically, as will be explained later.

The data for carrying out the extraction calculations are secured from a triangular binodal solubility plot. If such a plot for the desired system is not available in the technical literature, the data may be easily secured in the laboratory.*

Now, in following through the application of the McCabe-Thiele method, perhaps the best way is to show its use in an actual extraction problem. Chloroform is to be employed to extract acetic acid from aqueous solution. This solvent has been chosen for the example because of the very large change in distribution coefficient which occurs with its use. The distribution coefficient increases from a ratio of 0.064 to 0.233 as the mols of acid per liter increase in the water layer from 0.5 to 3.0. It will be seen that this large change presents no calculation difficulties.

Problem—Suppose the acid in a 54 per cent aqueous acetic acid solution is to be extracted with chloroform. The aqueous layer leaving the extraction battery is to contain no more than 1 per cent acid. Determine the number of extraction units required in a battery to perform this separation and the concentration of the hydrated acid leaving the battery in the heavy layer. Find the ratio of pounds chloroform required per pound of feed.

Solution—In Fig. 2 is a triangular binodal solubility diagram for the system chloroform-water-acetic acid on which are shown a number of conveniently spaced tie lines. The ends of each line represent the compositions of two layers in equilibrium. These lines can be located

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*Weigh accurately about 30 c.c. of solvent into each of five 100 c.c. stoppered glass cylinders. Add to each of these respectively 5, 10, 20, 30, and 40 grams of accurately weighed component to be extracted. Mix well by shaking. Add water to each of these solutions from a burette until upon shaking vigorously, a slight turbidity occurs which lasts several minutes. This turbidity indicates the appearance of two liquid phases; the addition of any further water will cause the two layers to separate. Compute the weight per cent of the three components in each of the five slightly turbid solutions, and plot these five points on a triangular graph paper. Continue the curve through these points to the points representing the solubility of pure solvent in water and of water in pure solvent. This will give the binodal solubility curve. If the curve indicates the desirability of intermediate points, these may be determined in a similar manner.

It will be found that the above titration end points will be sharp with high ratios of solvent to water, but increasingly more difficult to observe as the ratio decreases. Minute quantities of a water insoluble dye added to the mixture will aid the accurate determination of this end point.

All titrations must be made at a constant temperature. A water bath is well suited for this purpose.

After the data for the binodal solubility curve have been plotted, add exactly 10 c.c. (10 grams) of water to each of the five slightly turbid mixtures, shake well, and transfer to separatory funnels in which the two layers are allowed to separate. Analyze a portion of each layer for the weight per cent of its most easily detected constituent. Connect the point on the solubility curve representing the weight per cent of this component in the heavy layer with the point representing the weight per cent of the same component in the corresponding upper layer. If this tie line passes through the point in the triangular diagram representing the overall composition of the two layer mixture, the accuracy of analysis is checked and no duplicate determinations are necessary.

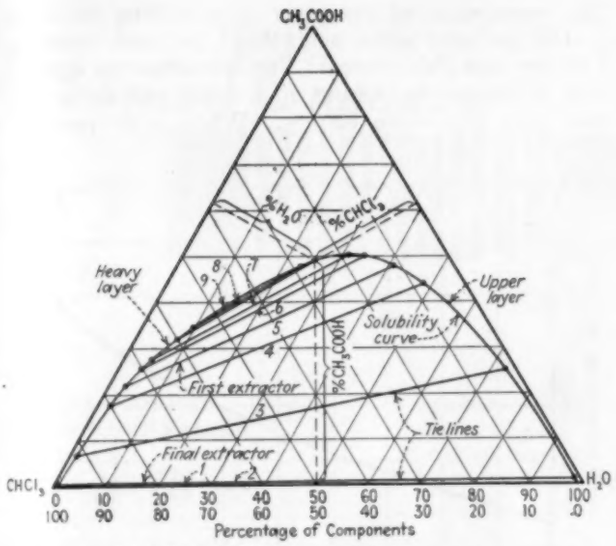


Fig. 2—Triangular binodal solubility curve for system chloroform-water-acetic acid, with tie lines connecting certain layers in equilibrium

as described in the footnote if the curve is obtained by laboratory determination. If, however, the solubility plot is available from the literature, a number of the lines can readily be located by the method of Evans (*Ind. Eng. Chem. Anal. Ed.*, **6**, 1934, p. 408) which requires no analysis but simply the separation and weighing of the two layers formed when various proportions of three components are shaken together. When several lines have been determined a simple relation can be used in locating any other lines required: Make a graph, plotting the percentage of acetic acid in one layer, at one end of each of the several lines already on the chart, against the corresponding acid percentages at the opposite ends of the lines, that is, in the second layer. Then any point on the graph will show the per cent acetic acid at each end of a tie line, or in two layers in equilibrium.

Among the tie lines required, it will be necessary to determine the two which represent the limits of the system. One line must connect the points representing the respective compositions of the two layers in the first extractor and the other the conditions in the last extractor. Since the problem states that the aqueous layer in the final extractor must contain no more than 1 per cent acetic acid, assume 0.90 per cent which, from the solubility chart, will be found to correspond to a layer composition of 0.90 per cent acetic acid, 98.25 per cent water and 0.85 per cent chloroform. The opposite end of the tie line from this point, as determined by the method outlined in the preceding paragraph, will show the composition of the equilibrium heavy layer to be 0.16 per cent acetic acid, 1.04 per cent water and 98.80 per cent chloroform.

Locating the tie line for the first extractor requires a little manipulation. Probably the simplest way is to plot several values of the expression:

$$\frac{\text{Per cent acetic} \times 100}{\text{Per cent acetic} + \text{per cent water}}$$

against the corresponding values of the per cent chloroform, as determined from a number of points along the upper layer side of the solubility curve. By interpolating between points the per cent chloroform is found which corresponds to a value of this expression equal to the per cent acetic acid in the feed. The point on the curve having this per cent chloroform then becomes one end of the tie line, while the opposite end is determined as in the case of the tie line for the final extractor. The values thus found for the first extractor are 48 per cent acetic acid, 41 per cent water and 11 per cent chloroform for the aqueous layer and 22 per cent acetic acid, 3 per cent water and 75 per cent chloroform for the heavy layer. The actual values will be somewhat different, since some of the acid will be extracted by the heavy layer in the unit, but the error will not be large enough to alter the number of extractors required.

Table I shows the equilibrium data as determined for the layer compositions at the opposite ends of the nine tie lines shown on Fig. 2. The number of mols of each component per 100 lb. of corresponding layer has been determined directly from the weight per cent composition, and X and Y, the mol fractions of acetic acid in the heavy and upper layers, respectively, from the number of mols.

Applying Data to Graphical Solution

The first step using the data as finally assembled is to determine the average number of mols of acetic acid in each layer throughout the extraction battery. This is done by drawing the graphs of Figs. 3 and 4 which are readily plotted from the data in Table I. The upper layer graph is integrated in the usual manner between the limits represented by the mol fraction of acetic acid in the final and first extractors; these are 0.015 and 0.800, respectively, which gives an integration value of 3.517. Dividing this integration value by the difference in limits of 0.785 gives U_{av} equal to 4.475. The process is repeated with the heavy layer graph giving an integration value of 0.3708 and a difference in limits of 0.364. H_{av} equals 1.020. The ratio H_{av}/U_{av} equals 0.228 which is the slope of the McCabe-Thiele operating line.

Next it is necessary to draw an equilibrium diagram, plotting the values of X and Y (from Table I) as in Fig. 5. On the same chart the operating line is drawn

Table I—Summary of Layer Composition Data for System Chloroform-Water-Acetic Acid, Based on Fig. 2

Tie Line No.	Heavy Layer: Weight Per Cent			Heavy Layer: Mols per 100 Lb. Layer					Upper Layer: Weight Per Cent			Upper Layer: Mols per 100 Lb. Layer				
	Chloroform	Water	Acetic	Chloroform	Water	Acetic	Total Mols	X	Chloroform	Water	Acetic	Chloroform	Water	Acetic	Total Mols	Y
1	99.01	0.99	0	0.830	0.055	0.	0.885	0	0.84	99.16	0	0.007	5.500	0	5.507	0
2	98.80	1.04	0.16	0.827	0.058	0.003	0.888	0.003	0.85	98.25	0.90	0.007	5.460	0.015	5.480	0.003
3	91.85	1.38	6.77	0.768	0.077	0.113	0.958	0.118	1.21	73.69	25.10	0.010	4.100	0.418	4.528	0.093
4	80.00	2.28	17.72	0.670	0.127	0.296	1.093	0.271	7.30	48.58	44.12	0.061	2.700	0.736	3.497	0.211
5	75.00	3.00	22.00	0.628	0.167	0.367	1.161	0.316	11.00	41.00	48.00	0.092	2.278	0.800	3.170	0.252
6	70.13	4.12	25.75	0.588	0.229	0.429	1.245	0.344	15.11	34.71	50.18	0.127	1.930	0.836	2.893	0.289
7	67.15	5.20	27.65	0.562	0.289	0.462	1.312	0.352	18.33	31.11	50.56	0.154	1.730	0.844	2.728	0.309
8	59.99	7.93	32.08	0.503	0.440	0.535	1.478	0.362	25.20	25.39	49.41	0.211	1.410	0.823	2.444	0.336
9	55.81	9.58	34.61	0.468	0.533	0.577	1.577	0.366	28.85	23.28	47.87	0.242	1.293	0.797	2.332	0.342

with a slope of 0.228, passing through the point represented by the pure solvent entering the final extraction unit, or $X = 0$, $Y = 0$.

Starting with the point on the equilibrium curve represented by the values of X and Y for the final extraction unit, namely $X = 0.003$ and $Y = 0.003$ (Table I), pass horizontally to the operating line, thence vertically to the equilibrium curve, and so on until the horizontal line cuts the vertical line represented by X = mol fraction of acetic acid in the first extraction unit, or $X = 0.316$. The number of intersections with the equilibrium curve will be the required number of extraction units, that is, four extraction units will be required.

The composition of the two layers in the first extraction unit is indicated in Fig. 5 by the final intersection with the equilibrium line which shows $X = 0.125$ and $Y = 0.098$. Since these values represent mol fractions of acetic acid in the heavy and light layers, respectively, the composition of the two layers in the first extraction unit can be determined by comparison with the triangular

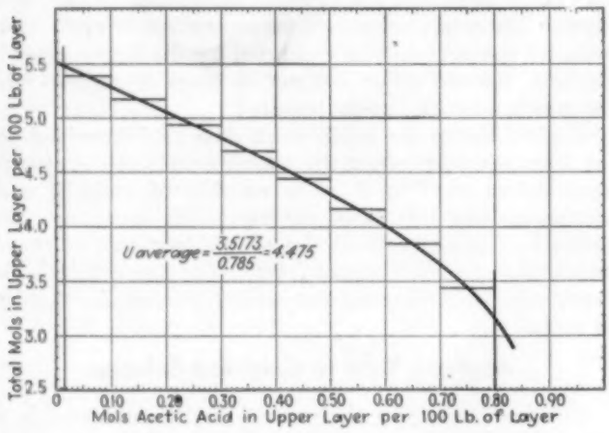


Fig. 3—Graph for determining average total mols in upper layers

diagram. This is perhaps most easily done by making a separate graph for each layer. Plot mol fractions of acetic acid against per cent chloroform for several points on the upper layer in one graph and for the heavy layer in the second graph. Read off the per cent chloroform in each layer corresponding to the mol fraction acetic acid of that layer in the first extraction unit. Locate the chloroform percentages on the triangular diagram, and read off the corresponding layer compositions. When $X = 0.125$, the equilibrium composition of the heavy layer is found to be 91.3 per cent chloroform, 7.2 per cent acetic acid, and 1.5 per cent water; likewise when $Y = 0.098$, the equilibrium composition of the upper layer is found to be 1.5 per cent chloroform, 72 per cent water, and 26.5 per cent acetic acid. The strength of the hydrated acid leaving this first extractor in the heavy layer is $7.2 \times 100/(7.2 + 1.5) = 83$ per cent acetic acid.

The ratio of solvent to feed is, of course, easily determined from the composition of the heavy and upper layers leaving the extraction battery. The aqueous acid feed composition is 54 per cent acetic acid, 46 per cent water, and 0 per cent chloroform. The composition of the heavy layer leaving the battery is 7.20 per cent acetic acid, 1.50 per cent water, and 91.30 per cent chloroform. The composition of the upper layer leaving the battery is 0.90 per cent acetic acid, 98.25 per cent water, and 0.85 per cent chloroform. Two simultaneous equations may be written by setting up a water and an acid balance over the whole battery. When x = pounds of

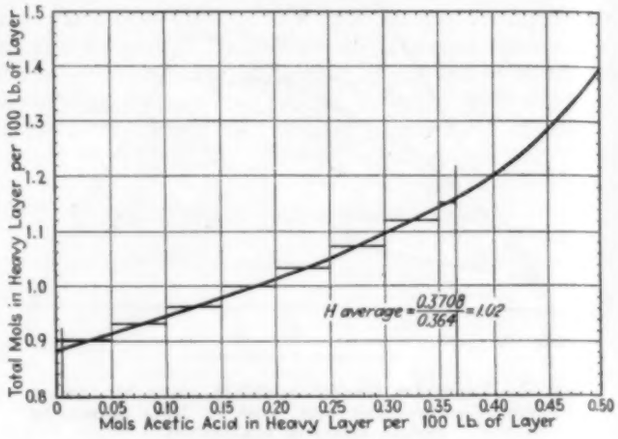


Fig. 4—Graph for determining average total mols in heavy layers

heavy layer leaving per 100 lb. of aqueous feed entering and y = pounds of upper layer leaving per 100 lb. of aqueous feed entering, then

$$0.015x + 0.9825y = 46$$

and

$$0.072x + 0.0090y = 54$$

Solving, we find that $x = 745.6$ lb. of heavy layer leaving per 100 lb. of aqueous acid feed entering and $y = 35.4$ lb. of upper layer leaving per 100 lb. of aqueous

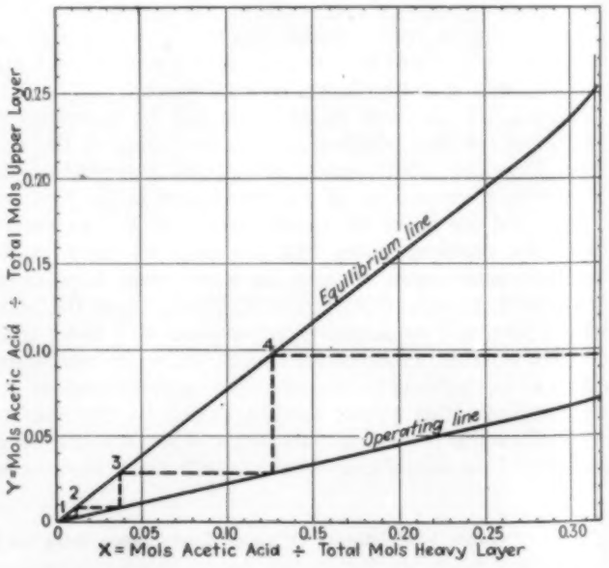


Fig. 5—McCabe-Thiele diagram developed for extraction problem outlined in text

acid feed entering. Expressing this in terms of pounds of chloroform, we find that $(0.913 \times 745.6) + (0.0085 \times 35.4) = 681$ lb. of chloroform is required per 100 lb. of aqueous acid feed. This gives the ratio of solvent to feed of 6.81.

Chemical Engineer's BOOKSHELF

Anthony Adverse Of Paint and Varnish

PHYSICAL AND CHEMICAL EXAMINATIONS OF PAINTS, VARNISHES, LACQUERS AND COLORS. (Seventh Edition). By *Henry A. Gardner*. Published by the Institute of Paint and Varnish Research, Washington, D. C. 1,445 pages. Price, $10.

Reviewed by *J. R. M. Klotz*

WHEN Hervey Allen's "Anthony Adverse" came out, one of our leading periodicals sent a copy to a celebrated reviewer and for a long time could not obtain his review. Letters and telegrams were of no avail and finally the telephone was resorted to and the editor was advised by the celebrated reviewer that he had not finished the book as yet and did not think he would for some time. The editor concluded from this that the book must be dull and heavy, but the reviewer assured him quite the contrary, that it was such an enjoyable affair that he did not want to finish it and have the task completed.

Your reviewer is in somewhat of the same position with regard to this stupendous volume of Dr. Gardner's. We sincerely hope that it finds its way into every laboratory that is at all concerned with paints, varnishes, lacquers, and protective coatings in general.

Dr. Gardner has done a work which is just about proportional to his status in this industry. He covers an enormous range of subjects which are ably discussed and splendidly illustrated. It is quite impossible for a reviewer to point out the very great virtues of this book without filing a compendium.

To give a good illustration, however, of its value, I would particularly point to Chapter 14 described as "Particle Size and Texture of Pigments." To one going about in the paint and varnish industry this is a revelation. Dr. Gardner has clearly set forth with splendid photomicrographs and sketches of apparatus, covering some 50 pages, a summary of this very enlightening section of paint and varnish chemistry that comes very near being worth the price of the book.

Further, in the chapter on "Examination of Volatile Thinners" Dr. Gardner has in some 30-odd pages summed up the productive efforts of numerous suppliers in clear, concise language, which if diligently followed by the laboratorian, in a comparatively limited time he can become an expert with a minimum of effort.

We feel quite certain that every important laboratory will want to own this volume and have it readily available to its staff and should there be any that have overlooked it so far, we cannot commend it too strongly. It is an extremely valuable addition to our literature.

A Business Biography

ONE THING LEADS TO ANOTHER: THE GROWTH OF AN INDUSTRY. By *Fred C. Kelly*. Published by Houghton-Mifflen Co., New York. 105 pages. Price, $1.75.

Reviewed by *S. D. Kirkpatrick*

SEVERAL MONTHS ago I had an interesting visitor—a man whose name is widely known to my fellow addicts of the *Satevepost* or the magazine sections of the Sunday papers. As we talked, "one thing led to another," but eventually we got down to chemistry, for Fred Kelly had just come back from the corn country and wanted to speculate a bit on what the future might hold for a corn-using chemical industry. Soon I found that he was far ahead of me, with a vision of practical possibilities for chemical industry that would occur only to a careful student whose observations were backed up by a homely, human philosophy. I discovered that Mr. Kelly had gone out, on his own, to make a study of Commercial Solvents Corp. from the viewpoint of a small stockholder, unschooled in either the intricate technology or the complicated commercial ramifications of the business. He remained to write what he calls a "business biography." It goes behind the statistics of the balance sheet to reveal the real philosophy and spirit "inevitably a part of the evolutionary process in *any* successful company."

But he also learned a great deal about the scientific pioneering work of this chemical company and what is more, he writes about it in a sober, understanding way that will be appreciated by the laymen among the stockholders of many of our companies. Here, in short, is pretty close to what I would regard as an ideal piece of public-relations work—something that many chemical corporations might undertake as a step toward better understanding of their programs and problems. And in this particular job, Mr. Kelly's fine writing is made all the more effective by the use of almost a score of well selected specimens of Miss Margaret Bourke-White's photographic art, and a glistening cover-jacket that appropriately reflects a new application of solvents in the pyroxylin lacquering of paper.

Solutions in Theory and Practice

THE SOLUBILITY OF NON-ELECTROLYTES. By *Joel H. Hildebrand*. An American Chemical Society Monograph. Published by the Reinhold Publishing Corp. New York City. 193 pages. Price, $4.50.

Reviewed by *William Abramowitz*

DESIGNATION of this book as an A.C.S. Monograph reveals its nature—a thorough study by a leading worker in the field. The fundamental problem is to join in a consistent theory the variation of the forces determining the composition of a solution with the properties manifested. In its interpretation we may ultimately comprehend the laws, at present but dimly defined, governing the most commonplace yet most important of phenomena, solubility, vapor pressure, distribution ratios, and reaction mechanisms.

Ideal solutions are first discussed since within certain limits they approximate actual solutions. Deviations are then accounted for by the action of various disturbing forces, either molecular or intermolecular. The electric fields around polar molecules and nonpolar molecules are described and their influence on solvation and association. The chapters on the vapor pressures of liquid mixtures and on the solubilities of liquids in liquids and of solid non-electrolytes in liquids are of particular interest.

The literature is critically evaluated, references being employed only as they contribute to the continuity of the treatise. The author aims to present not a perfected explanation but a stimulus for further research. But as ever where research leads applicability follows. The chemist confronted with immediate practical problems will find the subject matter, especially the conclusions emphasized in bold-face type, of surprising value.

Resultful Research

GLANCES AT INDUSTRIAL RESEARCH: DURING WALKS AND TALKS IN MELLON INSTITUTE. By *Edward R. Weidlein* and *William A. Hamor*. Reinhold Publishing Corp., New York City. 246 pages. Price, $2.75.

THIS is a big year in the colorful history of Mellon Institute. The forthcoming dedication of the great new building in Pittsburgh during the senior author's presidency of the American Chemical Society promises to be an occasion of international import. What could be more appropriate, therefore, than a sparkling little treatise on industrial research—particularly the productive variety that has added so many recent achievements to the proud records of the Institute? And who could better write it than the authors of "Science in Action"? Their literary efforts, ably supported by the best the graphic arts have to offer in typography and illustration, have given us a most instructive and readable account of the philosophy, methods and opportunities and, most important of all, the results of research.

Quantitative Colorimetrics

COLORIMETRIC METHODS OF ANALYSIS. By *F. D.* and *C. T. Snell*. Published by D. Van Nostrand, Inc. New York City, 717 pages. Price, $9.50.

Reviewed by *W. L. Abramowitz*

IT IS NOW but thirty years since dimethylglyoxime was first used in the determination of nickel. During this relatively short period colorimetry has assumed its important role in the science of analytical chemistry. The infant volume begotten by Dr. Snell in 1921 has grown to a lusty maturity. The present edition marks a welcome and completing step in the presentation of colorimetric and related methods of analysis, and the authors, by reason of long experience and laboratory contact, are well qualified to declare with authority upon the subject.

The material, in essence a critical compilation, is admirably systematized. The first nine chapters are designed to provide a comprehensive working background for the intelligent and discriminative use of the methods. Terms are defined, the laws applying described, and a survey offered of existing apparatus, their manipulations, spheres of utility, and limitations. The applications of nephelometry, photometry, and turbidimetry are also discussed.

Thirty-eight of the more common metallic and semi-metallic elements are treated, a separate chapter being generally assigned to each. By the new methods listed manganese, phosphorous, nickel, titanium, and combined carbon may be determined in iron or steel in a few minutes. Although the subject matter is limited entirely to inorganic chemistry as far as the unknowns to be determined are concerned, there are included many citations of bio-chemical procedures such as the analysis of tissue for iron or of food for copper. References to non-metallic constituents include carbon, carbon monoxide and dioxide, halides, sulphides, sulphites, hydrogen peroxide, ammonia, nitrates, cyanides, and fifteen others. There are four excellent chapters dealing with indicators and hydrogen ion concentration measurements.

No other current book as thoroughly covers the various aspects of these methods of analysis. With its detailed incorporation of the literature, it will prove invaluable to the chemist seeking comprehensive sources for his work in both the pure and the applied fields, and particularly in the latter, for "the applications to rapid control methods in industry have barely been touched."

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Report on the Cost of Producing Crude Petroleum. Petroleum Administrative Board unnumbered document; 15 cents. Information with reference to the approximate average cost of crude petroleum at wells and estimated recoverable reserves in the United States.

National Standard Petroleum Oil Tables. Bureau of Standards Circular 410; 20 cents.

Production, Heat Treatment, and Properties of Iron Alloys, by Louis Jordan. Bureau of Standards Circular 409; 10 cents.

World Chemical Developments in 1935, by C. C. Concannon and A. H. Swift. Bureau of Foreign and Domestic Commerce, Trade Information Bulletin 832; 15 cents.

The Leather Industry, 1935—a Bibliography, by J. G. Schnitzer. Bureau of Foreign and Domestic Commerce, Leather and Rubber Division unnumbered document; mimeographed.

Market Research Sources, by Rachel Bretherton. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series 55, 1936 edition; 25 cents. A guide to information on domestic marketing.

The Netherland Oilseed-Crushing Industry, by Homer Brett. Bureau of Foreign and Domestic Commerce Trade Information Bull. 830; 5 cents.

The Thiem Method for Determining Permeability of Water-Bearing Materials and Its Application to the Determination of Specific Yield, by Leland K. Wenzel. U. S. Geological Survey Water-Supply Paper 679-A; 10 cents. Results of investigations in the Platte River Valley, Nebraska.

Workers in Subjects Pertaining to Agriculture in State Agricultural Colleges and Experiment Stations 1935-36. Department of Agriculture Miscellaneous Publication 234; 15 cents.

List of Bulletins of the Agricultural Experiment Stations for the Calendar Years 1933 and 1934, by Catherine E. Pennington. Department of Agriculture Miscellaneous Publication 232; 10 cents.

Annual Report of the Commissioner of Internal Revenue Fiscal Year Ended June 30, 1935; 15 cents. Contains statistics for alcohol, tobacco, and oleomargarine industries.

Safety Codes for the Prevention of Dust Explosions. Bureau of Labor Statistics Bulletin No. 617, Supplement to Bulletin No. 562; 10 cents.

The Urinary Excretion of Silica by Persons Exposed to Silica Dust, by J. J. Bloomfield and others. Public Health Service Reprint No. 1712; 5 cents.

Atmospheric Pollution of American Cities for the Years 1931 to 1933, by James E. Ives and others. Public Health Service Bull. 224; 10 cents. With special reference to the solid constituents of the pollution.

Lubricating Oil, General Information, Requirements and Methods of Test. Navy Dept., Bureau of Engineering, N. Eng. 31; 5 cents. Revision of 1934 edition.

Sawdust, Wood Flour, Shavings, and Excelsior. Forest Products Division, Bureau of Foreign and Domestic Commerce; mimeographed, 7th edition.

Comparative Statistics of Imports Into the United States for Consumption by Countries for the Calendar Years 1931-1935 inclusive. Tariff Commission series of mimeographed documents in eleven volumes as follows: I Animals and Animal Products, Edible; II Animals and Animal Products, Inedible; III Vegetable Food Products and Beverages; IV Vegetable Products, inedible; V Textiles; VI Wood and Paper; VII Nonmetallic Minerals; VIII Metals and Manufactures; IX Machinery and Vehicles; X Chemicals and Related Products; XI Miscellaneous. Individual volumes available from Tariff Commission on request.

Cement. Statistical Appendix to Minerals Yearbook, 1935, U. S. Bureau of Mines; 5 cents.

Mineral Production Statistics for 1935—preliminary mimeographed statements from Bureau of Mines on: Fluorspar; lead; copper; zinc; magnesite; Indiana oolitic limestone; cadmium; sulphur; magnesium; zinc oxide; rolled zinc; value of mineral products of the U. S., 1933-1934, by states.

Patents on Geophysical Prospecting Issued in the United States, England, Canada, Australia, Germany, France, and Russia, by W. Ayvazoglou. Bureau of Mines Information Circular 6883; mimeographed.

Alums and Aluminum Sulphate, by John B. Umhau. Bureau of Mines Information Circular 6882; mimeographed.

Trends in White-Pigment Consumption, by Paul M. Tyler. Bureau of Mines Information Circular 6881; mimeographed.

Anhydrous Sodium Sulphate From Saline Deposits or Brines by a Four-Stage Process, by J. E. Conley and Everett P. Partridge. Bureau of Mines Report of Investigations 3299; mimeographed.

Notes on Testing the Explosibility of Coal Dusts and a Proposal to Have an International Test Method, by Geo. S. Rice and H. P. Greenwald. Bureau of Mines Information Circular 6878; mimeographed.

Charts for Determining the Performance of Centrifugal Fans, by G. E. McElroy. Bureau of Mines Report of Investigations 3298; mimeographed.

Progress Report on Investigation of Detachable Rock-Drill Bits, by McHenry Mosier. Bureau of Mines Information Circular 6877; mimeographed.

Check Determinations of Grindability of Coal by Various Methods, by W. A. Selvig. Bureau of Mines Report of Investigations 3301; mimeographed.

Your Plant NOTEBOOK

NOMOGRAPH FOR COAL ANALYSIS CONVERSIONS

By D. S. Davis
Dale S. Davis' Associates
Watertown, Mass.

COAL ANALYSES and heating values are commonly reported on three bases: the "as-received," the "dry" and the "ash-and-moisture free." For purposes of comparing various coals as to proximate and thermal values it is essential that all data be expressed on the same basis, requiring, usually, some type of conversion calculation. Alignment charts are admirably adapted to computations of this type and it is the purpose of this paper to present two such charts and to illustrate their use with typical examples.

Proximate Analysis Chart

The chart in Fig. 1 covers conversion of proximate analyses and is arranged so that each scale bears three designations, broken lines connecting the three corresponding legends. The outer axes are doubly graduated and in any given conversion one works entirely with the scales at the left or at the right of both axes. As an example of the use of Fig. 1, convert the analysis given in the accompanying table from the as-received basis to the dry basis and to the ash-and-moisture free basis. The last two columns list the results to be obtained from the chart.

As-Received Basis to Dry Basis—Connect 17.0, the percentage of volatile matter on the as-received basis (found at the left side of the left axis) with 3, the percentage of moisture on the same basis (central scale) and produce the line to meet the right axis at 17.5, the percentage of volatile matter on the dry basis, found at the left side. In the case of the fixed carbon, align 71.0 (left axis, right side) with 3 on the central scale and extend the line to 73.2 on the right side of the right axis. Similarly, the percentage ash on the dry basis is found to be 9.3.

As-Received Basis to Ash-and-Moisture Free Basis—Following the second line of legends, connect 17.0, the percentage of volatile matter (as-received basis) on the left axis with 3 + 9 or 12, the sums of the moisture and ash percentages (as-received basis) on the center scale and produce the line to meet the right axis in 19.3, the percentage of volatile matter on the ash-and-moisture free basis. In a similar manner, but working at the right of both outer axes, the percentage of fixed carbon on the ash-and-moisture free basis is found to be 80.7.

Dry Basis to Ash-and-Moisture Free Basis—Given the percentages of volatile matter, fixed carbon, and ash on the dry basis as 17.5, 73.2, and 9.3 respectively, what is the analysis on the ash-and-moisture free basis? Following the third line of corresponding legends, align 17.5, the percentage of volatile matter on the dry basis (left axis) with 9.3, the percentage of ash on the dry basis (center axis) and extend the line to 19.3 (right axis) which is the percentage of volatile matter on the ash-and-moisture free basis. Similarly, connect the percentage of fixed carbon on the dry basis, 73.2 (left axis) with 9.3 on the center scale and produce the line to meet the right axis at 80.7, the percentage of fixed carbon on the ash-and-moisture free basis.

In Fig. 1 the outer scales run between 7 and 100 per cent. Values lower than 7 may be handled by first multiplying by ten, and later dividing the result by ten.

Fig. 1—Chart for proximate analysis conversions

Percentages on As-recd. basis
Percentages of Moisture on as-recd. basis
Ash + moisture on-as-recd. basis
Ash on dry basis
Percentages on Dry basis
Ash-and-moisture free basis
Ash-and-moisture free basis
7 8 9 10 12 14 16 18 20 25 30 35
20 25 30 35 40 50 60 70 80 90 100
50 20 10 0
35 30 25 20 18 16 14 12 10 9 8 7
100 90 80 70 60 50 40 35 30 25 20

Heating Value Chart

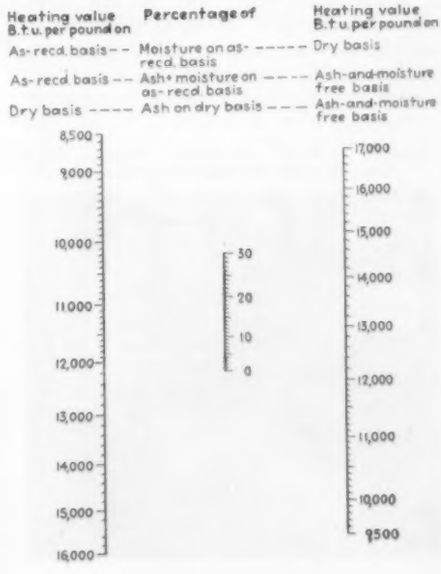
The use of the heating value chart, Fig. 2, in facilitating conversions may be illustrated as follows: Given a coal with a thermal value of 13,400 B.t.u. per pound, a moisture content of 3.0 per cent and an ash content of 9.0 per cent, all data being on the as-received basis, what is the heating value per pound of dry coal and per pound of combustible, that is, ash-and-moisture free coal?

As indicated by the first line of legends above the scales, a straight edge connecting 13,400 B.t.u. on the left with

Analysis on Three Bases of West Virginia Semi-Bituminous Coal

	As Received	Dry	Ash and Moisture Free
Moisture	3.0	...	...
Volatile matter	17.0	17.5	19.3
Fixed carbon	71.0	73.2	80.7
Ash	9.0	9.3	...
	100.0	100.0	100.0

Fig. 2—Chart for heating value conversions


Heating value B.t.u. per pound on As-recd. basis
Percentage of Moisture on as-recd. basis
Ash + moisture on as-recd. basis
Dry basis
Ash on dry basis
Heating value B.t.u. per pound on Dry basis
Ash-and-moisture free basis
Ash-and-moisture free basis
8,500 9,000 10,000 11,000 12,000 13,000 14,000 15,000 16,000
30 20 10 0
17,000 16,000 15,000 14,000 13,000 12,000 11,000 10,000 9500

3.0 per cent in the center will cut the scale at the right in the value, 13,800 B.t.u. per pound of dry coal. Following the second line of legends, connect 13,400 B.t.u. per pound of coal on the as-received basis (left) with 3 + 9 or 12, the sum of the moisture and ash percentages (as-received basis) and produce the line to meet the scale at the right in the value, 15,200 B.t.u. per pound of coal on the ash-and-moisture free basis.

Given the heating value and the percentage of ash, both on the dry basis, as 13,800 B.t.u. and 9.3 per cent, respectively, what is the thermal value on the ash-and-moisture free basis? According to the third line of legends align 13,800 on the scale at the left with 9.3 per cent on the central scale and extend the line to meet the scale at the right in the value, 15,200 B.t.u. per pound on the ash-and-moisture free basis.

Variable Speed Belt Weigher Controls Alum Feed

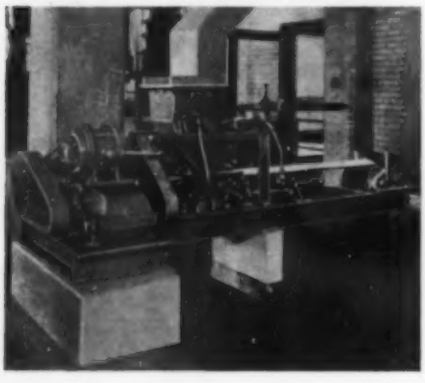
By Francis A. Westbrook
Consulting Engineer
Center Conway, N. H.

AN INTERESTING and somewhat unusual application of variable speed control is found in Minneapolis where the city water supply, taken from the Mississippi River, is treated with alum fed through a Schaffer Poidometer. In order to vary the rate of alum feed in accordance with the turbidity of the river water, variation in the speed of the Poidometer belt is necessary.

When the turbidity is low, as little as 0.1 grain of alum per gallon may be sufficient, but when it is high, as much as 9 grains per gallon may be required. The weighing belt, therefore, is set for a constant delivery of 4 lb. per foot of travel and the belt velocity adjusted in gradations of 0.1 ft. per hour at any desired speed between 37 and 887 ft. per hour. Depending on alum requirements, any desired quantity can thus be delivered simply by setting the corresponding belt speed. The delivery is checked by a recorder driven by the belt.

Minneapolis uses five of the units described at two stations. How they are hooked up will be clear from the accompanying view which shows a 1-hp. motor driving the constant speed shaft of a Reeves transmission. The variable speed shaft of the transmission drives the weighing belt through a two-speed reducer. Roller chain drives are used for the connections. The set up is one that should prove useful in other chemical plant applications.

Variable speed automatic weigher for feeding alum in water purification

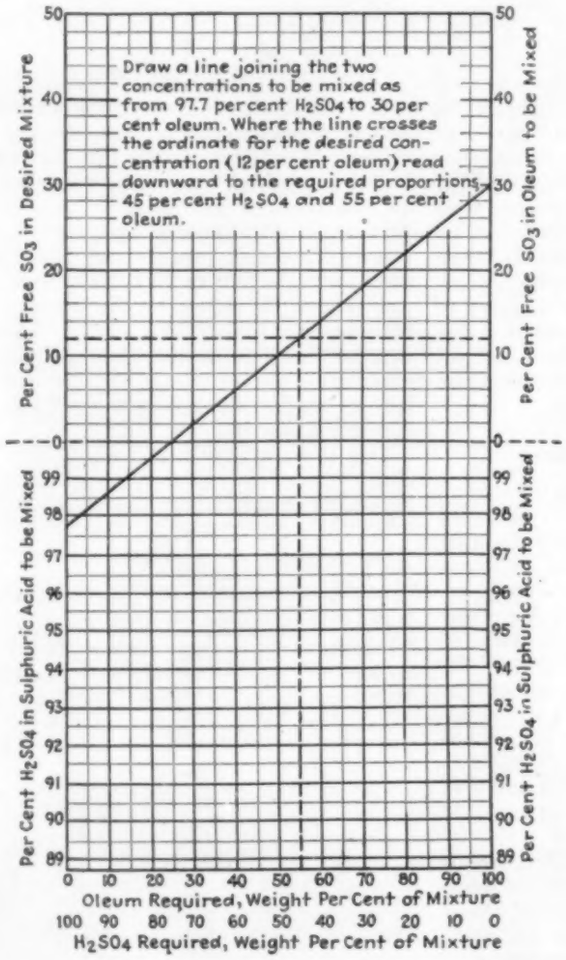


Proportional Chart Solves Oleum-Acid Mixtures

By J. S. Baker
Chemical Department
E. R. Squibb & Sons
Brooklyn, N. Y.

IN RECENT YEARS several shortcut methods have appeared in the literature to simplify the proportioning of mixtures of sulphuric acid and oleum. Certain of these methods (*Chem. & Met.*, Dec., 1933; Mar., 1935) have been based on Pearson's Square and require calculation with the possibility of confusion owing to the necessity of expressing both acid and oleum on the same base. The nomographic method (*Chem. & Met.*, Mar., 1936) avoids both calculation and confusion of bases but employs five scales and two turning lines. The new chart shown herewith has the conversion of bases built into it, as in the case of the nomograph, but is still easier to use since it is required only to solve a simple proportion through the drawing of a single line. It was designed by constructing two identical vertical scales with percentages of total SO_3 as graduations. The scales were then recalibrated, using the tables for sulphuric acid and oleum, in the more familiar terms of per cent H_2SO_4 for the acid part of the scales, and per cent free SO_3 for the oleum portion. The two were connected by a horizontal proportional scale.

It is obvious that a straight line connecting any two SO_3 concentrations on the two scales will cut the ordinate representing the SO_3 concentration of the desired mixture at a horizontal distance between the scales proportional to the required relative percentages of the two components. The example drawn on the chart shows that 55 per cent of 30 per cent oleum and 45 per cent of 97.7 per cent H_2SO_4 must be mixed to produce an oleum of 12 per cent free SO_3.


Draw a line joining the two concentrations to be mixed as from 97.7 per cent H2SO4 to 30 per cent oleum. Where the line crosses the ordinate for the desired concentration (12 per cent oleum) read downward to the required proportions, 45 per cent H2SO4 and 55 per cent oleum.
Per Cent Free SO3 in Desired Mixture
Per Cent Free SO3 in Oleum to be Mixed
Per Cent H2SO4 in Sulphuric Acid to be Mixed
Per Cent H2SO4 in Sulphuric Acid to be Mixed
Oleum Required, Weight Per Cent of Mixture
H2SO4 Required, Weight Per Cent of Mixture

Simple proportional chart for determining proportions of sulphuric acid and oleum to be mixed to produce an acid or oleum of desired concentration

Five for One

These, or better, are the odds when you contribute to "Your Plant Notebook." CHEM. & MET. solicits short items on useful chemical plant kinks and helpful chemical engineering shortcuts. At least $5 will be paid for each acceptable article.

News of EQUIPMENT

Improved Centrifugal Drive

What is called the two-motor free-wheeling drive for centrifugals is a new device recently announced by the American Tool & Machine Co., 1415 Hyde Park Avenue, Boston, Mass. Despite many improvements that have recently been made in centrifugal design, resulting in vastly increasing the operating capacity, it is stated that existing driving mechanisms were inadequate for the greatest unloading efficiency. It is pointed out that two distinct driving problems are involved in centrifugals. One type of drive is required for accelerating and driving the basket during the whizzing period. A much lower constant speed, with plenty of power, is required for the unloading period. These criteria have led to the new design which consists of a main motor directly connected to the spindle by a flexible coupling, combined with a smaller gear-motor unit of sufficient capacity to drive the basket while the load is being plowed out. This second motor is connected to the centrifugal by whatever transmission means may best suit the operating conditions. A free-wheeling device incorporated in this transmission automatically disengages when the main driving motor is running. Electrical interlocks prevent both motors from being energized simultaneously.

Two-motor centrifugal drive showing direct-connected arrangement

Among advantages mentioned for the new unit which, incidentally, is being offered to other centrifugal manufacturers, is the fact that the main motor may be designed exclusively for high acceleration and suitable operating characteristics, without regard to unloading requirements. Another advantage is automatic maintenance of the proper unloading speed so that the operator can give his entire attention to the action of the discharger, with resultant decrease in unloading time. In one instance the time for unloading a 40-in. centrifugal with an old style drive varied between 2½ and 3½ min., whereas a 48-in. centrifugal with the new drive was unloaded in less than 30 seconds.

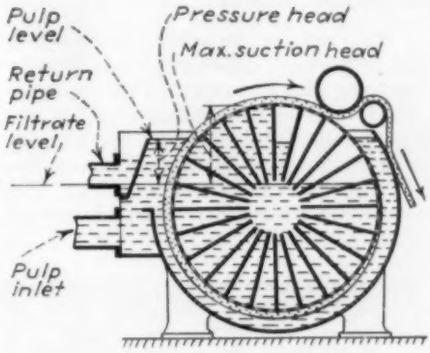
Continuous Conveyor Scale

Continuous weighing and integration of the load passing over a section of conveyor belt is the function of a new conveyor scale recently developed by Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill. The new scale is said to give results well within factory tolerance, accurate to 0.5 per cent.

The integrating mechanism consists of a cone and rotating switch driven by a flexible shaft from the conveyor. An integrating wheel driven by the cone may be raised or lowered by a reversible motor so as to contact a different diameter of the rotating cone. The integration of weight is effected by the differential in speed between the integrating wheel, rotated by the cone, which depends upon its vertical position on the cone, and the rotating switch which rotates in the same direction, but at the same speed as the cone. When there is no load on the belt the integrating wheel rotates on the diameter of the cone which is the same as that of the wheel, so that no differential is effected with the switch. When a load comes on the scale-borne section of the belt, the beam closes a contact, starting the reversible motor and raising the integrating wheel until its speed is proportional to the load. This proportionality is then converted into electrical impulses which are totalized on a tonnage register.

Valveless Rotary Filter

Novel design is incorporated in a new rotary filter that has recently been introduced in Europe by T. An. Tesch A/B, Kungsgatan 29, Stockholm C, Sweden. This filter, which is especially adapted to the handling of light pulps, such as cellulose, operates on fluid head entirely, requiring no valve,



Cross-section of new valveless filter

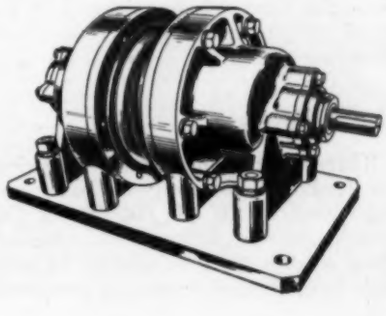
barometric leg or vacuum pump. As will be clear from the accompanying drawing, the inside of the filter drum contains a number of compartments formed by radial partitions and these partitions, during the rotation, produce what is described as a "shovel" action, lifting the filtrate above the discharge level as the discharge section is approached, thus sucking air through the cake, then dipping beneath the supply level and permitting the entrance of filtrate under hydrostatic head.

According to the manufacturers, the new filter has the advantages of simplicity, low installation cost, and low maintenance, owing to the absence of accessories.

Mechanical Vibrator

Double rotating weights are employed in a new way in a new design of mechanical vibrator recently introduced by the Ajax Flexible Coupling Co., Westfield, N. Y. Two offset weights, geared together, are mounted on shafts to rotate at the same speed but in opposite directions. The amplitude of vibration

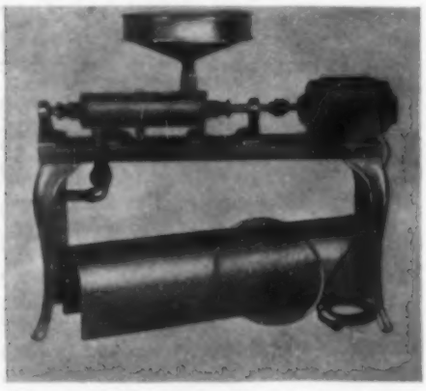
Unit for producing high-speed vibration



produced is controlled by the amount of offset weight. Alloy heat-treated steels and anti-friction bearings are employed and the unit is housed in an oil-tight dustproof housing. The unit shown in the accompanying illustration, when running at 4,000 r.p.m., delivers 8,000 strokes per minute, each having a force of approximately 2,400 lb.

Colloidal Mixer

Designed for the mixing and dispersing of pigment colors and clays, and for reducing the viscosity of fluid mixtures and for aiding the solution of solids, the new Crane colloidal mixer has been introduced by the Colloid Equipment Co., 30 Church St., New York City. The mixer consists of a series of 15 notched disks of special design which are assembled on a shaft at an angle of 18 deg. These disks are rotated within a cylinder at 1,750 r.p.m. The angular setting of the disks combined with the rotation of the shaft assembly is said to give a longitudinal wiping action as well as a rotary action. The result is said to be an intensive agitation of the material as it passes slowly through the cylinder.



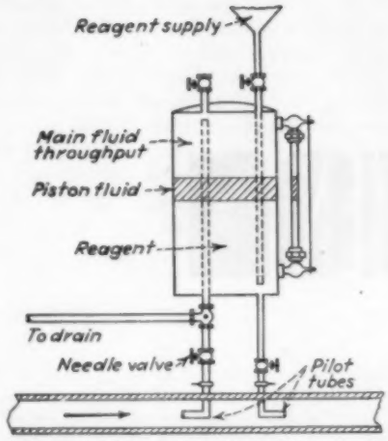
New colloidal mixer with cover removed

Construction is designed to be simple and rugged, without close clearances and without operating adjustments. Cadmium-plated parts in contact with the product are ordinarily employed, but special metals can be supplied if necessary.

The unit is powered with a ½-hp. motor and has a wide-open capacity of 250 g.p.h. for medium viscosity solutions. For extremely fine dispersing, the speed of passage can be reduced by throttling the outlet.

Liquid Feeders

Three new proportioning machines for feeding liquid reagents have been announced by D. W. Haering & Co., 3408 Monroe St., Chicago, Ill. Although these machines are all similar in principle to the feeder announced previously in *Chem. & Met.* (July, 1934, p. 379) they differ markedly in detail. All of them employ the direct transmission of fluid pressure differentials from pilot tubes to govern the discharge of the reagent in proportion to the rate of flow of the liquid to be treated. All utilize liquids as fluid pistons. The simplest of the new designs, shown in the accompanying drawing, is known as Model A. It employs an inert immiscible liquid, intermediate in density between the main fluid and the reagent, to act as the liquid piston. Models E and F each employ two tanks and incorporate a sight-feed device whereby the number of drops of reagent fed per unit of time can be counted. Model E is designed for feeding corrosive solutions and employs a rubber-lined reagent tank. Model F, designed for feeding oils and organic solvents into gasoline, oil or gas lines, is similar in principle to Model E, except that it employs as a fluid piston a liquid heavier than the reagent and main fluid and immiscible with oils and most organic solvents.

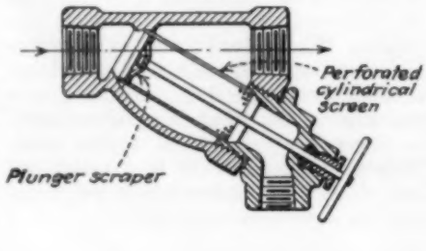


New Model A proportioner for liquid reagents

Pipe Line Strainer

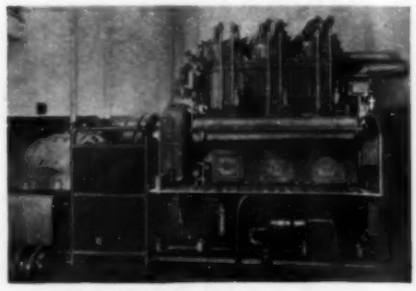
A modification of the well known pipe line strainer, which is fitted with a plunger or rotary scraper within the cylindrical screen, has been developed by the Sarco Co., 183 Madison Ave., New York City. One form, the type employing the plunger, is shown in the accompanying drawing. Both types are capable of being cleaned without removing the screen or shutting down the line. On this account they are said to take the place of duplex strainers which are several times as expensive.

Cross section of strainer with plunger for cleaning screen

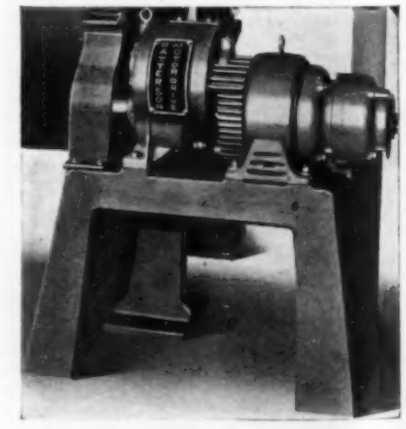


Diesel Engines

Type RHB is the designation of a new line of diesel engines built in sizes ranging from 100 to 800 hp. by the Chicago Pneumatic Tool Co., 6 East 44th St., New York City. These are four-cycle, direct-injection machines of the full diesel type, provided with pressure lubrication and readily convertible to the use of gas fuel. Particular attention has been paid to the accessibility of all parts. A new piston design and connecting rod are said to contribute to effective balancing. Cylinder heads have been especially designed to relieve all internal strain, while large water jackets with clean-out covers give effective and efficient cooling, according to the manufacturer.



150-hp. diesel driving a generator



Integral motor drive for mills

Mill Drive

For driving pebble, ball and tube mills, tumbling barrels, rotary mixers and similar equipment, the Patterson Foundry & Machine Co., East Liverpool, Ohio, has developed the new motorized drive shown in the accompanying illustration. The drive has a mechanical brake built into it so that when

the stop button is pushed the equipment driven stops immediately. By pressing an "inching" button the mill can be inched over into exact position for discharging. The drive is built in all sizes from 1 to 100 hp.

MANUFACTURERS' LATEST PUBLICATIONS

Alloys. Colmonoy Co., Los Nietos, Calif. —15-page booklet describing this company's wear-, corrosion- and heat-resistant alloys and overlay metals.

Alloys. Duraloy Co., Pittsburgh, Pa.—4 pages describing this company's centrifugal castings in chrome iron, and chrome-nickel and nickel-chrome alloys.

Alloys. Rustless Iron & Steel Corp., 1001 Edison Highway, Baltimore, Md.—4 pages briefly describing this company's corrosion- and heat-resisting stainless steels.

Belting. E. F. Houghton & Co., 240 West Somerset St., Philadelphia, Pa.—40-page belting manual with transmission data, engineering tables and simple belt formulas. Also describes this company's belting.

Blowers. Autovent Fan & Blower Co., 1805 North Kostner Ave., Chicago, Ill.—A.I.A.30d1—Loose-leaf catalog of bulletins describing blowers of various types; also ventilating fans; gives engineering data on all types.

Boilers. Babcock & Wilcox Co., 85 Liberty St., New York City—Bulletin G-17-A—24 pages completely describing this company's integral-furnace boilers.

Chains. Columbus - McKinnon Chain Corp., Tonawanda, N. Y.—Issue No. 7—Catalog on many types of chain, both welded and weldless, with information on purchasing and use.

Combustion. Hauck Manufacturing Co., 124-10th St., Brooklyn, N. Y.—60-page manual of industrial combustion data relating to oil and gas burning and combustion information in general, with particular reference to this company's burners and auxiliary equipment. Includes many tables of engineering data. Free to those directly concerned with industrial heating work; cost is $1 to others.

Crushers. American Pulverizer Co., 1249 Macklind Ave., St. Louis, Mo.—8-page bulletin describing various types of ring crusher made by this company, also illustrating applications.

Crushers. Jeffrey Mfg. Co., Columbus, Ohio—Catalogs 621 and 622—Respectively 20 and 8 pages, describing single-roll and double-roll crushers, showing numerous applications and listing capacity data.

Dermatitis. Milburn Co., 905 Henry St., Detroit, Mich.—8-page leaflet describing types of industrial skin afflictions, listing various preventive and protective products manufactured by this company.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1176—12 pages on electrically energized grids for controlling mercury arc rectifiers; also Bulletin 1177, 6 pages on high voltage power transformers.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—GEA-1661A—12 pages on metal-clad switchgear; also GEA-2326, 6 pages on cubicles with oil-blast breakers.

Engines. Troy Engine & Machine Co., Troy, Pa.—Bulletin 305—48 pages on vertical and horizontal steam engines manufactured by this company.

Equipment. Dechema, Potsdamerstrasse 103a, Berlin W. 35, Germany—1935-36 Annual of Dechema (Deutsche Gesellschaft für Chemisches Apparatewesen E.V.) describing for the first time in German, English and French, equipment and apparatus, etc., exhibited at the last German Chemical Exposition in 1934. Sent free on receipt of three international reply coupons to cover postage.

Equipment. Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 2239—4 pages describing a new aftercooler for air and gas compressors of moderate capacity; also Catalog 7502-E, 28 pages describing Type 30 industrial compressors and vacuum pumps.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: S-500-B29, Vertical four-cycle diesel engines; W-111-B8, Horizontal single-piston 200-lb. steam pumps; W-111-B9, Horizontal single-piston 75-lb. steam pumps; W-210-B20, Savings with feed water heaters; W-317-B5, Submerged centrifugal pumps; W-318-B7, Multi-stage centrifugal pumps; W-320-B2, Centrifugal fire pumps; W-321-B6A, Condensate return units; W-323-B3A, Motorized centrifugal pumps; W-423-B3, Triplex power pumps.

Fittings. Bonney Forge & Tool Works, Allentown, Pa.—Bulletin WT-21—12 pages on Weldolet and Thredolet forged weld fittings.

Fittings. Tube-Turns, Inc., 425 Fifth St., Louisville, Ky.—Catalog 107—48-page catalog and price list on seamless-drawn weld fittings, also showing applications.

Flotation. Denver Equipment Co., 1419-17th St., Denver, Colo.—Bound collection of catalogs on flotation machines, thickeners, diaphragm pumps, concentrating tables, jigs and agitating equipment.

Grilles. Cornell Iron Works, 3600-13th St., Long Island City, N. Y.—8-page booklet describing this company's rolling steel grilles for door openings, illustrating applications.

Heaters. American District Steam Co., North Tonawanda, N. Y.—Bulletin 35-76—Describes U-tube water heaters for heating or cooling water, oils and liquids.

Instruments. Bausch & Lomb Optical Co., Rochester, N. Y.—Catalog D-20—32 pages completely describing instruments for spectrographic analysis; also Bulletin D-221, 32 pages with price list on spectrometric equipment.

Instruments. The Bristol Co., Waterbury, Conn.—Publications as follows: Bulletin 440, covers this company's new series of Ampliset Free-Vane controllers; Bulletin 444, describes new Model 90 pneumatic type controller for temperature, etc.; Catalog 1250, 88 pages on modern thermometry and this company's instruments for temperature measurement and control.

Instruments. Brown Instrument Co., Philadelphia, Pa.—24-page booklet discussing instruments from executive viewpoint; also leaflet briefly describing this company's potentiometer pyrometers; also novelty folder illustrating by means of actually turnable dials how this company's Air-o-Line automatic controllers can be "tuned in" to the requirements of individual processes.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletin 436—12-page pamphlet on the use of graphic instruments in making plant surveys.

Instruments. The Foxboro Co., Foxboro, Mass.—Leaflet describing this company's Vernier Valvactor, an auxiliary device for providing exact valve response in control installations; also folder briefly describing this company's recording thermometers.

Instruments. G-M Laboratories, Inc., 1731 Belmont Ave., Chicago, Ill.—16-page catalog on photoelectric and galvanometric equipment made by this company.

Instruments. The Hays Corp., Michigan City, Ind.—Catalog RA-346—14-page catalog illustrating and describing principles of combustion indicators and recorders made by this company.

Instruments. Practical Instrument Co., 2717 North Ashland Ave., Chicago, Ill.—Folder describing this company's low-priced recording thermometers and electrical operation recorders.

Instruments. Thwing-Albert Instrument Co., Lancaster Ave., Philadelphia, Pa.—First issue of a new house organ, the "Thwing Paper Tester," discussing physical testing of paper on a weight basis.

Lubricants. Woburn Degreasing Co. of N. J., Harrison, N. J.—9-page pamphlet, first of a series, in this case describing this company's extreme-pressure lubricant.

Materials Handling. Lewis-Shepard Co., Watertown, Mass.—Circular 199—6-page folder illustrating a wide variety of stackers and portable elevators, both hand and power operated, offered by this company.

Materials Handling. Stephens-Adamson Mfg. Co., Aurora, Ill.—Catalog 42—36 pages completely describing the Redler conveyor made by this company, showing its applications in numerous industries.

Metals and Alloys. Metallurgical Products Co., 35th and Moore Sts., Philadelphia, Pa.—24-page guide and directory of metals, their alloys and byproducts, with reference to their purchase by this company as scrap materials.

Microscopes. Pfaltz & Bauer, Inc., 300 Pearl St., New York City—32-page book describing Reichert universal camera microscopes.

Motors. Lincoln Electric Co., Cleveland, Ohio—6-page folder with prices and engineering data on this company's line of general-purpose squirrel-cage induction motors.

Motors. Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio—16-page handsomely illustrated book describing tests and certain manufacturing operations employed in building this company's electric motors.

Paint. Hercules Powder Co., Wilmington, Del.—Folder concerning use of Tornesit in house paints.

Power Transmission. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Catalog 1500—208 pages on bearings, hangers, pulleys, gearing, shafting and other power transmission equipment.

Power Transmission. Ohio Gear Co., 1333 East 179th St., Cleveland, Ohio—128-page catalog on gears and motorized speed reducers with technical data and engineering information.

Power Transmission. Oilgear Co., 1301 West Bruce St., Milwaukee, Wis.—16 pages completely describing this company's recently improved hydraulic variable speed transmission.

Power Transmission. Philadelphia Gear Works, "G" St. and Erie Ave., Philadelphia, Pa.—28-page bulletin describing this company's motorized horizontal and vertical speed reducers and flexible couplings, including two new speed reducer sizes.

Power Transmission. Reeves Pulley Co., Columbus, Ind.—6-page leaflet briefly describing principles of the three basic types of this company's variable speed transmission equipment, illustrating also various modifications.

Pumps. Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill.—Bulletin 6310—8 pages on low-head propeller pumps for large quantities of water.

Pumps. Morris Machine Works, Baldwinsville, N. Y.—Bulletin 160—4 pages describing a high-speed, non-clogging centrifugal pump made by this company.

Refractories. Babcock & Wilcox Co., 85 Liberty St., New York City—8 pages on this company's refractory mortars and plastics; also eight pages on insulating firebrick offered by this concern.

Refractories. E. J. Lavino & Co., 1528 Walnut St., Philadelphia, Pa.—Pamphlets by G. E. Sell, technical director of the company, on petrography and heat treatment of chromite refractories, and refractories from a metallurgical viewpoint; also chart for mutual conversion of the pyrometric cone temperature scale, Fahrenheit and Centrigrade scales.

Refractories. Quigley Co., 56 West 45th St., New York City—Bulletin 320-A—4 pages on Insulcrete, light-weight insulating concrete put out by this company.

Separators. Dings Magnetic Separator Co., Milwaukee, Wis.—Catalog 25—34 pages on magnetic separators in general with particular reference to magnetic pulleys and pulley type separators.

Steam Generation. Commonwealth Electric & Mfg. Co., 83 Boston St., Boston, Mass.—Leaflet briefly describing and listing prices on this company's electrically heated automatic steam boilers; also feedwater regulators, pumps and condensate return systems.

Strainers. H. A. Brassert & Co., 310 South Michigan Ave., Chicago, Ill.—Leaflet describing this company's automatic strainers for removing large percentages of foreign materials from water or other liquids.

Valves. Edward Valve & Mfg. Co., East Chicago, Ind.—Catalog 11-A10—17 pages on valve material specification standards with respect to valves for high temperatures and pressures.

Valves. Hancock Valve Division, Consolidated Ashcroft Hancock Co., Bridgeport, Conn.—Bulletin 7000—20-page booklet describing and illustrating this company's new line of forged-steel valves for steam pressures up to 1,500 lb.

Ventilators. American Larson Ventilating Co., Pittsburgh, Pa.—A.I.A. 12k1—16 pages of engineering information on this company's roof ventilators.

Vibrators. Syntron Co., Pittsburgh, Pa.—Catalog of bound bulletins describing this company's vibrating equipment for hoppers, feeders, conveyors and weighers.

Welding. Linde Air Products Co., 30 East 42d St., New York City—12 pages on the oxy-acetylene welding of brass and bronze.

Chemical Engineering NEWS

Chemical Engineers Hold Business Session

THE semi-annual meeting of the American Institute of Chemical Engineers was held in New York, June 12. As the Institute will have a joint technical session with the British engineers later in the month, this meeting was confined to the transaction of business. It was attended mainly by those members who were in New York for the purpose of embarking on the steamer for the International meeting in London.

The first William H. Walker award of the Institute was made to Allan P. Colburn of the duPont Experimental Station, E. I. duPont de Nemours & Co., Inc., Wilmington. The award was made for an outstanding contribution to chemical engineering literature, published in the *Transactions* by a member. The purpose of the award is to stimulate interest in shaping a better chemical engineering literature.

This was followed by the announcement and awarding of the prizes in the annual student chapter problem contest. Henry G. Staaterman of New York, a senior in chemical engineering at Cooper Union, New York, has been awarded a $100 first prize. The second prize of $50 was awarded to Paul A. Mills of Paulding, Ohio, a senior at Ohio State University, Columbus, and the third prize of $25 went to John H. Johnsen of Chicago, a senior at the Armour Institute of Technology, Chicago. Three other contestants won honorable mention—Walter J. Ewbank of Lawrenceburg, Ind., a student at Purdue University; Charles E. Leyes of Jersey City, a senior at Cooper Union; and Francis J. McAdams of New York, a Columbia University man.

This year's contest, according to Dr. A. McLaren White, chairman of the committee on student chapters, showed a marked improvement in the form of the solutions and in the interest shown. Large and small colleges in all parts of the country did extremely well, with the prize winners well distributed geographically, and no one section showing a predominance of talent.

Announcement was made that in view of the illness of A. E. Marshall, J. V. N. Dorr would head the American delegation to the International Chemical Engineering Congress, with J. G. Vail, vice-president and technical director of the Philadelphia Quartz Co., and S. D. Kirkpatrick, editor of *Chem. & Met.* as assisting members of the committee.

Dr. Parmelee Will Address A.S.T.M. Meeting

ONE of the major features of the Thirty-ninth A.S.T.M. Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, June 29-July 3 inclusive, is to be an address on the "Relationship of A.S.T.M. to Modern Developments in Chemical Engineering" by Dr. H. C. Parmelee, *Editor, Engineering and Mining Journal.* This address will be given in the opening session on Tuesday morning, June 30, at which time, H. S. Vassar, will give the President's Annual Address.

At the nineteen sessions of the meeting, there will be given some 120 technical papers and reports. Of the 70 papers, twelve comprise the extensive Symposium on Radiography and X-ray Diffraction Methods to which four sessions are devoted on Tuesday and Wednesday. This symposium covers the application of these methods to both metallic and non-metallic materials. Five papers are to be given in the Symposium on the Limitations of Laboratory and Service Tests in Evaluating Rubber Products, Thursday evening.

Other groups of papers pertain to spectrographic analysis, boiler feedwaters, cement and concrete, soils, asphalts, non-ferrous metals and paint.

Since 1936 is a year of publication of the triennially issued Book of A.S.T.M. Standards, many of the Society committees have extensive reports giving their recommendations on many specifications to be adopted as standard and included in the volume. A large number of new proposed specifications are expected to be approved at the meeting for publication covering many materials for which standardized requirements have not previously been issued. About 50 reports will be presented in abstract by the various officers.

Research Develops Uses For Oiticica Oil

CHEMISTS and practical paint, varnish and lacquer makers are finding the potentialities of Brazil's new oiticica oil increasingly interesting. Paint and varnish makers see in the oiticica product, another quick drying oil for specialty products, that may serve as an active rival for the better known tung oil, which the South American oil closely resembles in odor and in other important characteristics.

Approximately 1,000 tons of the oiticica oil has been imported since 1934 when it began to come prominently into the chemical and industrial picture. Of that quantity the bulk was used by small manufacturers of paints and varnishes to replace the tung oil then hard to obtain because of a shortage in the supply.

Experiments conducted by several scientists and practical chemists, shows oiticica oil weathers well when made into varnishes containing phenolic resins. Varnishes made with 100 parts of phenolic resin to 200 parts of oiticica oil have given most satisfactory results under trying conditions.

Dr. H. A. Gardner, Jr., of the National Paint, Varnish and Lacquer Association, Inc., Washington, D. C., has been conducting a series of experiments, aimed at determining effects of treating the oil with various organic substances, prior to its use with a varnish resin. Results of those experiments can not be given in full as yet, but there are indications that methods can be developed by which the oil can be so modified as to make it equal, if not superior, to tung oil in the formulation of ester gum varnishes.

Grasselli to Have Exhibit At Cleveland

CHEMICALS used in wood preservation, in industry, and in agriculture, along with a complete miniature metal finishing plant will comprise the Grasselli Chemical Company exhibit at the Great Lakes Exposition which opens in Cleveland, Ohio, June 27, and continues until October 4. The exposition commemorates the one hundredth anniversary of the founding of Cleveland and will be open one hundred days. The Grasselli exhibit will cover 886 square feet of space and will be located in the Lakeside Exposition Hall.

E. M. Allen to Head M.C.A. in Constructive Program

RETURNING on June 4 and 5 to the Seaview Golf Club at Absecon, N. J., after a three-year absence, the 64th annual meeting of the Manufacturing Chemists' Association went a long way toward establishing a broadly constructive program for chemical industry in 1936-7. Edwin M. Allen, president of the Mathieson Alkali Works, was elected president to succeed William B. Bell of the American Cyanamid Co., who is to continue on the executive committee of the association. Harry L. Derby, president of the American Cyanamid and Chemical Co., succeeds as chairman of that committee, Charles Belknap, executive vice-president of Monsanto Chemical Co., who was elected vice-president. George W. Merck, of Merck & Co., vice-president, J. W. McLaughlin, Carbide & Carbon Chemicals Corp., treasurer, and Warren N. Watson, Washington, D. C., secretary, were reelected. Under Mr. Derby's chairmanship the new executive committee includes in addition to Mr. Bell, Leonard T. Beale of Pennsylvania Salt Mfg. Co., Lammot du Pont of E. I. duPont de Nemours & Co., J. H. Dunbar of Grasselli Chemical Co., August Kochs of Victor Chemical Works, Clyde D. Marlatt of The Martin Dennis Co., Benjamin S. Mechling of Mechling Bros. Chemical Co., and Charles W. Millard of General Chemical Co.

Conspicuous contributions from outside the industry were made by Dr. Karl T. Compton, president of Massachusetts Institute of Technology, who spoke on "Dangers of Regimentation and Complacency;" and Mark Sullivan, Washington correspondent, who titled his banquet address "The Choice Ahead of Us."

In his annual report, Chairman Belknap of the Executive Committee, paid a high tribute to retiring president W. B. Bell for "sound leadership in a period of crisis," stressing particularly his foresight in avoiding dangerous pitfalls in steering the industry through the N.R.A. labyrinth. A present danger, just as insidious, according to the report, is seen in the Government's program of reciprocal tariffs. Later in the day the meeting went on record in a resolution strongly condemning this program "both in principle and in practice," primarily because these trade treaties had been negotiated without adequate opportunity for labor, industry and agriculture to be heard, and without approval of the United States Senate, as is provided in the Constitution. "Many of these (tariff) reductions," said Mr. Belknap's report, "will result in an increase of chemical imports, while concessions by foreign countries for the benefit of our chemical exports have been insignificant in comparison." The rapid progress of chemical manufacture in Japan, particularly direct competition from a number of low-priced chemicals, attracted wide attention.

Constructive work done by M.C.A. in the development of its well rounded safety program on shipping containers, precautionary labelling and plant practices came in for much commendation. So did the work of the several technical

E. M. Allen

committees and the special subcommittee under the chairmanship of Dr. W. S. Landis which had made an active study of the technical and economic phases of stream pollution in relation to chemical industry.

A worth-while innovation this year was the appearance of a number of exhibits of new types of chemical containers,—aluminum and stainless steel drums, fibre cartons, etc. The development of glass carboys from the old thin-wall balloon type through the various stages to the latest M.C.A. standard 13-gal. carboy was dramatically presented by Sub-committee Chairmen Maurice Crass, now of duPont's industrial engineering department, and Thomas Callahan of Monsanto (neé Merrimac).

Representatives of the technical and industrial press were not permitted to hear the scheduled address of President Bell, which for a number of years has been one of the outstanding features of these annual meetings. In the absence of any authorized abstract or official statement regarding this address, it can only be reported by hearsay that it was concerned largely with the subject of national politics. It is to be hoped that at least in other than years of presidential elections, this oldest and in some ways most progressive of chemical trade associations will not go back to the "star-chamber" sessions so roundly condemned in connection with the State Department's handling of the reciprocal tariff program.

President Compton's address, which may appear in greater length in a subsequent issue of *Chem. & Met.*, pointed out that "Among the greatest dangers which threaten our country and which are peculiarly in contrast with the spirit and philosophy on which chemical industry are founded are, broadly interpreted, the philosophy of regimentation and the danger of complacency." Dr. Compton said "The former of these is an insidious danger in government and the latter in both government and private institutions."

Speaking before 200 guests at the union dinner of M.C.A. and the Synthetic Organic Chemicals Manufacturers' Association, Mark Sullivan of Washington, outlined some of the common characteristics of the collectivistic type of government represented in Russia, Italy and Germany: (1) Greater latitude in definition to take in much of what we call the social and economic orders formerly outside of governmental activity, (2) centralization of power and practical suspension of legislative influence, (3) hostility to and repression of dissenting minorities, (4) regimentation and uniformity of rituals and symbols, (5) suppression of courts or disregard for their unique function, (6) surrender of personal liberties. Mr. Sullivan held that the two collectivist mechanisms tried in this country were the N.R.A. and the A.A.A. which if left to continue for a few years would have almost automatically taken us toward one of the European plans.

Monsanto Announces Plans For Expansion

A LARGE plant for the production of phosphoric acid will be built by the Monsanto Chemical Co. at Monsanto, Tenn., south of Columbia in Maury County where the company recently purchased several large tracts of land containing phosphate deposits, it was announced on May 18 by Edgar M. Queeny, president. Construction of a treating plant is under way and preparations for strip mining operations are being made. Power for the operations will be supplied by the Tennessee Valley Authority. Monsanto's Tennessee project constitutes a substantial part of the expansion program financed by the company's recently announced $6,000,000 stock issue.

Monsanto's development includes the expansion of its electric furnace operations and possible gradual removal of these operations from its subsidiary's plant at Anniston, Alabama, to its Tennesee properties. Production of abrasives and calcium carbide as well as phosphate compounds will continue at Anniston.

Monsanto also contemplates erecting a new high pressure boiler plant at its Monsanto, Ill. works.

SEESAWING of Congressional leaders over imposition of a duty of 4½ cents per pound—it figured out at about 34 cents per gallon—on tung and perilla oils, thoroughly alarmed the paint, varnish and lacquer interests of the country.

It also worried both the naval stores producers and the soybean growers, the first of whom saw in the tax proposed a body blow to the greatly increased demand for their rosins and turpentines in the manufacture of American paints and varnishes.

The proposal to impose the tax came from the flax growers who saw in the two quick drying oils a pair of formidable rivals for their own product.

This assertion is being flatly contradicted by the paint and varnish interests, who are quoting such authorities as the U. S. Tariff Commission and the report of the American Farm Bureau Federation on the interchangeability of oils and fats.

Tung oil properties, it is claimed, make it unrivaled by any other drying oil. Between 70,000 and 80,000 acres in Louisiana, Texas, Mississippi, Alabama and Florida are now planted to tung trees, some of which already are bearing and others rapidly nearing that point.

As is well known the use of tung or perilla oil permits the use of rosin. This of course aids the naval stores producers to solve the ever vexing problem of over production. More than 175,000 barrels of rosins were used by varnish makers during the recent tung oil boom, a total of close to 88,000,000 pounds of the southern product.

The domestic tung oil interests are opposed to the imposition of the tax because they believe it would force up the price of the oil and cripple the market for tung oil by forcing manufacturers to seek less expensive substitutes.

Opposition to the tax comes also from the soybean growers. Perilla oil, from Manchuria, is being used extensively as a carrier for soybean oil, a semi-drying oil, but which when properly blended with perilla can be used most satisfactorily in paints, enamels and linoleums.

Soybean producers asserted the tax would make the combination of the oils commercially unprofitable and so shut off one of the new and most profitable markets for their product.

Closing of the door to perilla oil would accentuate the effects of any tung oil shortage with a resultant increase in the price and the collapse of the market here, was the final claim of opponents.

Chaotic conditions long affecting production, transportation and distribution of Chinese vegetable oils, including tung and perilla, are now in a fair way of being permanently straightened out, according to advices reaching Washington from Shanghai and Hankow.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

The Hankow government has established a semi-official corporation to be known as the China Vegetable Oil Refinery, Ltd., and to be capitalized at 2,000,000 yen (about $740,000). This organization is to function as agent for the vegetable oil industry in China, standardize and improve production and control processing and storing.

This means that financing the oil producers will now be organized and placed on a business basis. No longer will barge loads of silver be sent up the rivers, exposed to the attack of pirates. No longer will boats loaded with tung oil jars be subject to the inroads of wandering bands of Chinese bandits.

Incidentally speculators both in China and this country, are going to find rigging the rapidly advancing vegetable oil markets more difficult than it has been in the past.

Only about one half of the capital of the refinery authorized will be subscribed for immediately, but the shares are to be bought by the Hankow Ministry of Industry and the governments of the five leading oil producing provinces.

The Tariff Commission has made available various preliminary figures on the production and sales of synthetic organic chemicals, including dyes, for the year 1935. These show large increases in output of practically all groups of products.

Among the synthetic organic chemicals not of coal-tar origin, many unusual increases in production are noted. The output of this group totaled 1,591,000,000 lb., with sales of 790,995,000 lb., valued at $86,053,000, or an increase over 1934 of 40 per cent in production, 24 per cent in sales volume, and 18 per cent in sales value. Synthetic methanol, the most important tonnage product, increased 41 per cent in output; acetic anhydride, 73 per cent; acetic acid, about 50 per cent; acetone, more than 70 per cent; amyl alcohol, over 100 per cent; isopropyl alcohol, over 90 per cent; and fermentation citric acid, more than 50 per cent over the preceding year. Among the many other products showing increases are chemicals used in the automobile and motor fuel industries, in synthetic fibers, and in solvents used for dry cleaning.

The output of 101,817,000 lb. of dyes in 1935 was 17 per cent greater than that in 1934 but 9 per cent less than in the peak year 1929. If the output of indigo in 1929 and 1935 be deducted from the totals for the respective years, the 1935 production exceeds that in 1929 by 6,000,000 lb., or 7 per cent. The production of indigo has declined sharply in recent years from 29,320,000 lb. in 1929 to 15,818,000 lb. in 1934 and to 13,614,000 lb. in 1935.

Another gain made by the chemical industry in 1935 was in the production of intermediates, the total of which was 436,811,000 lb., with sales of 191,055,000 lb. valued at $26,114,000 in 1935. The output exceeds 1934 by 12 per cent and 1929 by 24 per cent. In making the comparison with 1934, certain adjustment of the figures was necessary, because in 1934 rubber chemicals were classified as intermediates, whereas in 1935 they were included in miscellaneous finished coal-tar products. By deducting rubber chemicals from the total shown for intermediates in 1934, comparable figures were obtained. About 56 per cent of the production of intermediates in 1935 was consumed by the producers in the manufacture of other commodities.

Commercial use of the vacuum carbon-dioxide method for preserving shell eggs, recently developed by scientists of the Bureau of Chemistry and Soils, is proving the value of the process.

One firm is known to have treated several thousand cases of eggs by the method this season and other firms are reported to be making plans for utilization of the method, as an adjunct to cold storage.

An act setting the Federal Alcohol Control Administration free of the Treasury Department and revising current liquor revenue regulations has passed the Senate after some debate.

Though known as an Administration measure the bill is not on the "must list" mentioned by President Roosevelt. It has however the endorsement of both the Treasury Department and the Federal Alcohol Control body, which last would be given a free hand in the task of administration of the existing liquor laws. The existing situation has been the repeated cause of confusion and delay.

Exports of chemicals and related products from the United States continued at high levels in April with the demand for turpentine, sulphur, benzol, fertilizers, mixed paints and many other products being particularly active, according to the Department of Commerce.

Levant Fair Exhibits American Products

(Special Correspondence)

IN 1924, the Fair of the Levant was held for the first time, and occupied three small rooms and the yard of a public school in Tel-Aviv (Palestine). Today it must be counted amongst the five most important trade exhibitions of the world. The strategic location of Palestine at the crossroads of the main transit lines to Asia, Africa and Australia are contributing factors to this development as well as its own vast, but undeveloped hinterland which offers considerable promise for the future.

This year, April 30 to May 30 the exhibits covered 1,500,000 square feet, an increase of almost 40 per cent over 1934. Over 30 countries were represented, most of them officially; 15 had their own buildings, including Belgium, France, Great Britain, Holland, Poland, and Switzerland.

An agricultural division had been added under the supervision of M. T. Dawe, director of the Department of Agriculture of Palestine. The latest developments of crop production, fertilizers and animal husbandry were shown.

Firms from the United States exhibited agricultural machinery; refrigerators; fans and ventilators; electrical appliances; automobiles; building materials; glass, rubber, leather and metal products; sanitary installations; cosmetics and toilet goods; food products and so on.

American participation was organized by the American Near East Corp., of New York. It numbered 113 exhibitors against 38 only in 1934. American goods enjoy a very great popularity and it is expected that more consideration will be given to this Fair in the future not only on account of the rapid development within the country but also because it is well patronized from the entire Near East, Persia and India.

Production of Sulphur Gained Last Year

PRODUCTION of sulphur in the United States in 1935, according to the U. S. Bureau of Mines amounted to 1,632,590 long tons, a gain of 15 per cent over the 1,421,473 tons produced in 1934. Shipments increased slightly from 1,613,838 tons, valued at about $28,900,000 in 1934 to 1,634,990 tons, valued at about $29,300,000 in 1935. The quantity of sulphur in stock at the mines on Dec. 31, 1934, 3,100,000 tons, was unchanged at the close of 1935. Production of sulphur was reported from California, Louisiana, Texas, and Utah.

The output of sulphur in Texas in 1935 was 1,253,814 long tons, or 77 per cent of the country's total. These figures compare with a production of 1,187,233 tons in 1934. Production of sulphur was made on two new leases on Boling Dome, by the Duval Texas Sulphur Co. and by Baker & Williams. Other properties that contributed to the production in 1935 were those of the Duval Texas Sulphur Co. at Palangana Dome; Freeport Sulphur Co. at Bryanmound and at Hoskins Mound; and the Texas Gulf Sulphur Co. at Long Point Dome, and at Boling Dome.

Louisiana increased its production 62 per cent in 1935 with an output of 373,283 long tons compared with 229,830 tons in 1934. Shipments, however, decreased from 307,186 tons in 1934 to 275,747 tons in 1935. As in 1934, Freeport Sulphur Co. and Jefferson Lake Oil Co., Inc., were the producers.

In California and Utah production amounted to 5,493 long tons in 1935. The Bureau of Mines is not at liberty to publish these figures separately.

Gas Association Will Meet at Absecon

AT its last meeting the executive board of the Compressed Gas Manufacturers' Association decided to hold its usual summer meeting at the Seaview Golf Club, Absecon, N. J. The meeting will open on June 18 and will continue for three days. In addition to the regular business sessions a sports schedule has been arranged for June 19.

CALENDAR

INTERNATIONAL CHEMICAL ENGINEERING CONGRESS, London, England, June 22-27.

AMERICAN PULP & PAPER MILL SUPERINTENDENTS ASSOCIATION, Grand Rapids, Mich., June 24-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 29-July 3.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, Montreal, Aug. 3-6.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting, Pittsburgh, Pa., September 7-12.

ELECTROCHEMICAL SOCIETY, semi-annual meeting, Niagara Falls, N. Y., October 8-10.

NATIONAL METAL CONGRESS AND EXPOSITION, Cleveland, Oct. 19-23.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Chicago, Ill., November 9-12.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Baltimore, Md., November 11-13.

Pulp and Paper Plants For the South

IN AN editorial in the April issue of *Chem. & Met.* attention was called to the pulp and paper development under way in the Southern states. Already plans were under construction in Florida, Arkansas, Texas and Georgia.

Recently announcements have been made of two additional craft pulp mills for that same section of the country. At Port St. Joe, Fla., the St. Joe Paper Company had been incorporated and a plant will be constructed at a cost of approximately $7,500,000. The projects were organized and financial arrangements are being handled through the Almours Securities, Inc., of Jacksonville, Fla. The new plant will be operated by the new corporation and the officers of the new company are George H. Mead, chairman of the board, Sidney Ferguson, president, Charles R. Van der Carr, junior vice-president, W. T. Edwards, vice-president, Roger L. Main, treasurer, A. H. Marsh, assistant treasurer and secretary, N. K. Long, comptroller.

The West Virginia Pulp & Paper Company, of New York City has awarded contract to Norton C. Tuttle of Boston, Mass. for the pulp and paper mill to be erected near Charleston, S. C. The estimated cost is $5,000,000. The mill location is the old Port Terminal property, now owned by the city of Charleston.

Survey of World Chemical Industry Released

EFFORTS to create satisfactory synthetic products to take the place of natural imported raw materials and research into new chemical uses for surplus farm crops was intensified in 1935 and the early part of the current year, according to a world survey of the chemical industry released June 1 by the Commerce Department's Chemical Division.

Although production data are lacking, it is believed the United States continued to hold its position as the world's leading producer and consumer of chemicals. Germany remained the largest exporter of such products; foreign shipments from that country showing a 2 per cent increase in value over the preceding year against a 9 per cent increase in United States chemical exports.

The world chemical survey covers developments in close to 50 foreign countries, 40 of which are presented in considerable detail. Latin America, a region that is steadily growing in importance as an export field for American chemical products, is stressed in the survey. New products, barter, cartels, etc., are treated.

Albert L. Marsh

Allan P. Colburn

Duncan A. MacInnes

PERSONALITIES

FREDERICKS W. ADAMS has resigned from the faculty of the School of Chemical Engineering Practice at Massachusetts Institute of Technology to accept a position at Mellon Institute.

CHESTER L. KNOWLES has been appointed to the newly created position of chemical sales director of the Dorr Co. He will direct his energies to coordination of all the company's work in the chemical industries.

R. K. STRONG, formerly professor of chemical engineering at Oregon State College, has been appointed head of chemistry and chemical engineering at Rose Polytechnic Institute.

JOHN CLARKE has resigned from the firm of Knight and Clarke in which he was a partner. B. H. Knight will continue the New York consulting firm.

W. L. MCCABE, associate professor of chemical engineering at the University of Michigan, has resigned to accept a professorship of chemical engineering at the Carnegie Institute of Technology, Pittsburgh.

WILLIAM E. PIPER has resigned from the Dorr Co. to accept a position with the Standard Lime and Stone Co. where he will be occupied in the engineering and manufacturing of lime products.

DUNCAN A. MACINNES has been elected president of the Electrochemical Society. He specialized in physical chemistry while studying at the University of Utah, the University of Illinois and the Massachusetts Institute of Technology. At the present time he is an associate member of the Rockefeller Institute for Medical Research at New York.

THOMAS ROLINS, JR., has been made president of the Hewitt Rubber Corp., and F. G. Cooban, a chemical engineering graduate of Armour Institute of Technology and the University of Illinois, has been made vice-president of the organization.

PHILIP J. EHMAN joined the research staff of the Ansul Chemical Co., Marinette, Wis., on May 1. He had been connected with the Continental Can Co. as research chemist.

MAXIMILIAN TOCH, president of Toch Brothers, Inc., New York, has been elected president of the American Institute of Chemists. Robert J. Moore, development manager of the Bakelite Corp., Bloomfield, N. J., is the newly elected vice-president.

A. GEORGE STERN, who was recently with the A. R. Mass Laboratories of Los Angeles, Calif., has joined the U. S. Bureau of Mines as assistant to the chief engineer, Dr. A. C. Fieldner.

G. C. NORTH, formerly of the Wisconsin Alumni Research Foundation, has become affiliated with the Beatrice Creamery Co., Chicago, Ill. He will work in collaboration with members of the research staff of Arthur D. Little, Inc., Cambridge, Mass.

H. HELLER of the Mutual Chemical Co. of America, Baltimore, Md., is accompanying the American delegation to the International Chemical Engineering Congress, which will be held in London, June 22-27.

J. M. DEBELL has joined the technical department of the Fiberloid Corp., Indian Orchard, Mass. Formerly, he had been connected with the Hercules Powder Co.

ALFRED G. WHITE has been named chief of the Petroleum Economics Division of the Bureau of Mines and entered on his new duties the first of May. Mr. White was associated with the Bureau of Mines some years ago. He has also been on the staff of Wharton School of Finance of the University of Pennsylvania and more recently with the National Industrial Conference Board, in charge of studies relating to natural resources.

RALPH M. PALMER, consulting chemical engineer has been elected president of the Ferro-Nil Corp., New York, N. Y.

ULRIC B. BRAY has been appointed assistant manager of research, at the Los Angeles laboratory (Wilmington, Calif.) of the Union Oil Co. of California. Donald E. Carr has been appointed a research supervisor.

Rev. J. A. Nieuwland

REV. JULIUS A. NIEUWLAND of Notre Dame University, William H. Nichols medalist in 1935, died suddenly on June 11 at Washington, D. C.

MEDALISTS

ALLAN P. COLBURN, research chemical engineer of the duPont Experimental Station, E. I. duPont de Nemours & Co., Inc., Wilmington, Del., is the recipient of the William H. Walker Award from the American Institute of Chemical Engineers. The award is made for outstanding contributions to chemical engineering literature, published in the Transactions of the Institute by a member. This is the first time that the award has been made.

W. H. MACINTIRE, associated with the Tennessee Experiment Station and consulting chemist for the Tennessee Valley Authority, has been selected to receive the Charles H. Herty Medal for outstanding service in the field of chemistry in the south. Dr. MacIntire was named for the award because of his outstanding work in agricultural chemistry.

WILLIAM F. GIAUQUE of the University of California received the Charles Frederick Chandler Medal of Columbia University in recognition of his development of a method of magnetic cooling by which temperatures approaching absolute zero may be obtained. The medal is awarded annually by the University trustees for conspicuous work in the field of chemistry. It was established in 1910 in honor of Dr. Chandler.

ROGER ADAMS, head of the department of chemistry at the University of Illinois, received the 1936 Willard Gibbs Medal of the Chicago Section of the American Chemical Society. The award was made "for outstanding and fundamental contributions to synthetic organic chemistry and for conspicuous achievements as a teacher of chemistry."

ALBERT L. MARSH, president and general manager of the Hoskins Manufacturing Co., Detroit, has been awarded the John Price Wetherill Medal by the Franklin Institute. He receives the award "in consideration of the contribution of a material which has proved of extreme importance to the electrical industries." Mr. Marsh contributed an alloy which has been far reaching in making possible a greater use of electrical energy in industry as well as in the home.

GEORGE O. CURME, JR., vice president, Carbide & Carbon Chemicals Corp., is the recipient of the Elliott Cresson Medal presented by the Franklin Institute in consideration of his foundation of a new technology which has resulted in the development of a rapidly expanding industry—namely, that of synthetic aliphatic compounds—based upon the olefins as starting material; and his development of profitable uses for these compounds in industry.

UPTON B. THOMAS, JR. is the recipient of the Electrochemical Society's prize to young authors. This is an annual prize awarded to the author of the best paper printed in the Transactions of the Society during the year. Mr. Thomas of the Bell Telephone Laboratories was co-author with Dr. H. E. Haring of the paper entitled "Electrochemical Behavior of Lead, Lead-Antimony, and Lead-Calcium Alloys in Storage Cells."

MORRIS E. LEEDS, president of the Leeds & Northrup Co., Philadelphia, has been awarded the Henry Laurence Gantt Medal for "distinguished achievement in industrial management as a service to the community." The medal is given by the American Management Association. The specific contribution which Mr. Leeds has made to industrial management is the emphasis which he has placed in his activities upon the preparation of a suitable background in the attitude of all ranks of an organization toward methods for increasing efficiency.

HENRY B. LINFORD of the State College of Washington, Pullman, has been selected as the eighth Weston Fellow by the Electrochemical Society. Mr. Linford is planning a post-doctorate program to supplement his previous training. He will carry out his research under the direction of Dr. Colin G. Fink at Columbia University.

MORRIS JOSLIN BLISH has been awarded the Thomas Burr Osborne Medal by the American Association of Cereal Chemists.

Roger Adams

W. L. McCabe

Chester L. Knowles

Chemical ECONOMICS

ON THE basis of seasonally adjusted indexes of the Federal Reserve System, general industrial production in April increased to 100 per cent of the 1923-1925 average compared with 93 per cent in March. The automotive and steel industries had much to do with the rise in the index number. Improvement in the chemical-consuming industries was fairly general although some exceptions were noted. For instance in the textile field cotton goods manufacture was increased but declines were reported for silk and wool.

Plate glass production in April reached an all-time high with an output of 19,454,774 sq.ft. The previous high was 17,275,632 sq.ft. in January of this year. Production for the first four months of this year reached a total of 66,664,539 sq.ft. compared with 59,619,203 sq.ft. in the Jan.-April period of 1935.

Some manufacturing industries were reported to have shown a seasonal tapering off in May although activities in general were on a higher scale than in May, 1935. In certain branches of the chemical and allied industries, the movement of raw materials in May was reported to have exceeded that of April.

Consumption of crude rubber by manufacturers in the United States, for March, is estimated at 42,703 long tons, which compares with 36,746 long tons for February. March consumption shows an increase of approximately 16.2 per cent above February, according to the Rubber Manufacturers Association. Consumption for March, 1935, was reported at 42,620 long tons.

Production of byproduct coke in April was 3,466,417 tons. Benzol production was 8,543,000 gal. as compared with 7,782,000 gal. in March and 5,807,000 gal. in April last year. Total to the end of April was 31,453,000 gal. as compared with 24,629,000 gal. in the same period a year ago. Ammonia sulphate, or its equivalent, was 55,212 tons as against 51,614 tons in March, and 40,942 tons in April a year ago. Total to the end of April was 208,980 tons as against 170,803 tons in the similar period a year ago. Tar yield was 46,035,432 gal. in April; 43,224,936 gal. in March, and 35,607,625 gal. in April last year. Total for the end of April was 174,885,568 gal. as against 149,068,599 gal. in the similar period a year ago. Light oil output was 14,479,691 gal. in April; 13,595,695 gal. in March and 11,208,483 gal. in April, 1935. Total to the end of April was 55,007,391 gal. which compares with 46,883,931 gal. for the Jan.-April period of 1935.

The output of plastic products has failed to maintain the rate of increase shown last year but the outlook is regarded as favorable for continued expansion. It is reported that plans for 1937 automobile production call for a much wider use of plastics and if this report proves to be correct, a new record for output next year seems assured.

A firm trend in commodity prices is forecast for the coming six to twelve months in the summary of national business conditions as reported by the National Association of Purchasing Agents. The report, prepared by a committee of buyers, recommends that industrial buyers of the country maintain a policy of "being well covered" on essential materials.

According to the committee's summary, May business maintained the levels established in April in all sections of the country except the West where a decided improvement in general conditions was noted. Commodity prices showed a steady trend through the nation. Inventories were kept to the preceding month's levels and companies showed a decided tendency to cover in advance on requirements. In the East orders covered requirements for two to four months in advance. In the mid-West coverage was one to three months, in the West two to three months and in Canada one to two months.

Comments on general business in the report include the statement that: "Consensus seems to be that as a whole seasonal recession is to be expected through possibly the June-August period but that industry is on a definitely stable basis and both production and distribution should show considerable improvement by the time this year-end arrives."

Referring to the industrial group of commodities the report says:

"Included in this group would be lubricants, leather, rubber, paper, leather belting and other items of the maintenance type or those which are necessary in rehabilitation activities. There should be an increasing demand for most of these commodities during the next 15 months unless something occurs that is not at present apparent.

"Leather supplies are somewhat top-heavy at the moment but any further price reactions should afford good buying level. Paper has been increased in price not so long since and further firmness of moderate scope quite probable, due mostly to producers' contentions that higher manufacturing costs warrant increased selling values. Heavy potential output should preclude any marked upward movement, however.

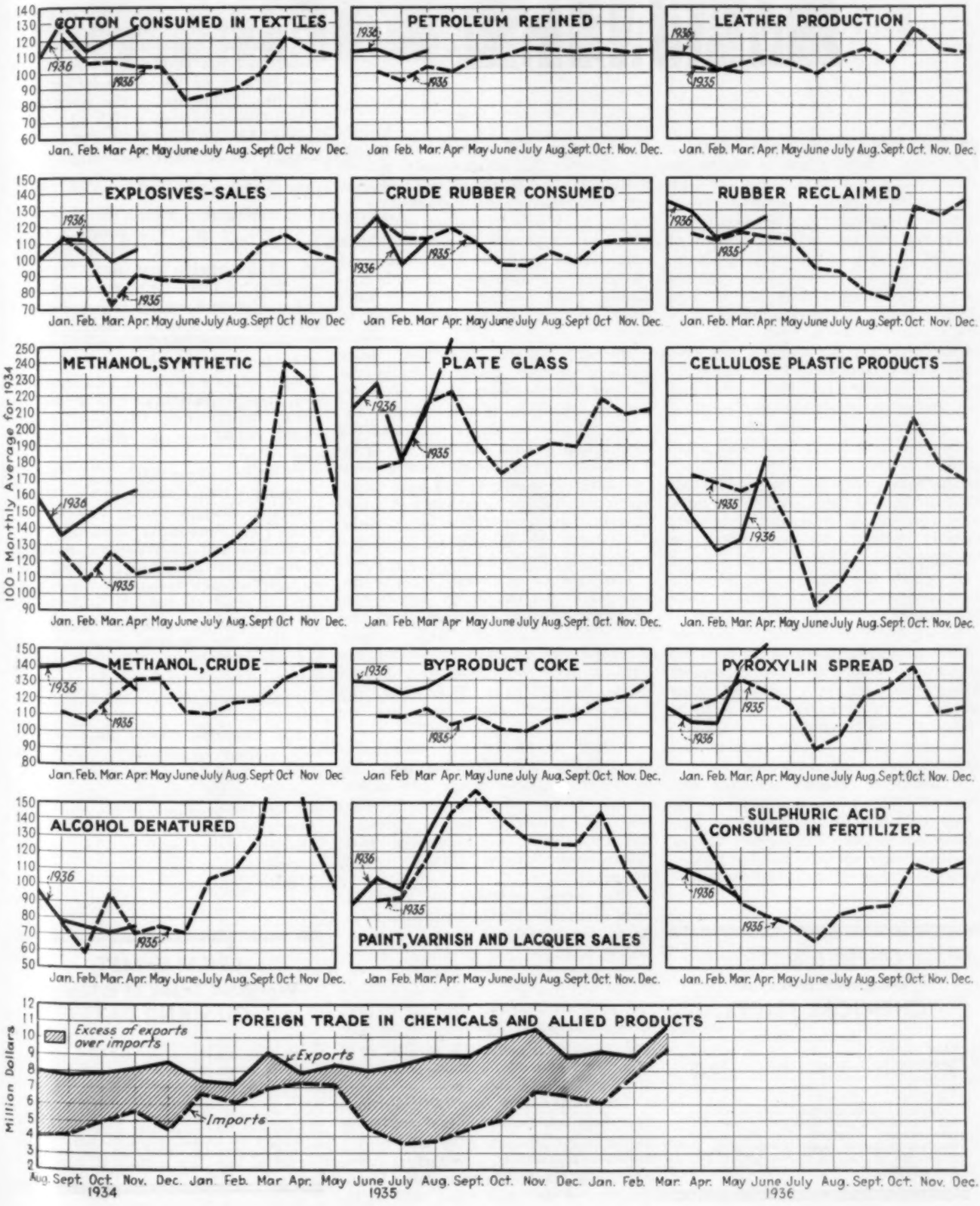
"Rubber is one of those commodities that shows rather marked recession in supply situation in this country, although there is far from any actual stringency from stock standpoint. While firm price trend still prevails, radical upward movement not expected, in fact, noticeably higher levels in this market will bring out further efforts toward production from secondary rubber as well as synthetic materials which might play an important part in this supply-demand relation. Purchases in this market should remain at least six months ahead of operations."

Production and Consumption Data for Chemical-Consuming Industries

	April 1936	April 1935	Jan.-April 1936	Jan.-April 1935	Gain Jan.-April 1936 over Jan.-April 1935 Per Cent
Production					
Automobiles, No.	502,775	452,936	1,575,356	1,500,808	5.0
Alcohol, denatured, 1,000 wi. gal.	5,953	5,554	23,697	23,666	...
Byproduct coke, 1,000 tons	3,466	2,670	13,173	11,164	18.0
Cellulose acetate products, 1,000 lb.	1,221	1,107	3,473	3,994	13.0*
Nitrocellulose acetate products, 1,000 lb.	1,388	1,311	5,164	5,615	8.0*
Methanol, crude, gal	426,313	450,941	1,891,034	1,612,525	17.3
Methanol, synthetic, gal.	1,692,921	1,167,282	6,283,787	4,900,482	28.2
Pyroxylin spread, 1,000 lb.	5,647	4,600	18,613	18,087	2.9
Plate glass, 1,000 sq.ft.	19,455	16,999	66,645	59,619	11.8
Rosin, wood, bbl.	54,209	46,028	210,384	177,063	18.8
Turpentine, wood, bbl.	8,662	7,049	35,024	26,578	31.9
Steel barrels, No.	721,322	614,385	2,420,695	1,979,392	22.3
Consumption					
Cotton, 1,000 bales	577	468	2,234	1,981	12.8
Silk, bales	34,564	39,757	141,612	173,279	18.3*
Paint, varnish and lacquer sales ($1,000)	36,377	32,851	110,510	101,460	9.0

*Per cent of decline.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

DEMAND for chemicals shows a spotty condition due to the prevalence of seasonal conditions on both sides of the market. The movement of fertilizer chemicals has slowed down but citric and tartaric acid have been of greater interest. Deliveries of alkalis in May, in some quarters, were reported to have been larger than they were in April. Some of the coal-tar products are reported to be in small supply due to the fact that consumption has kept pace with production. Paint materials are still moving freely and a good call for plating chemicals has continued.

Consumption of solvents for the year to date has been better than in the comparable period of last year, but price competition shows no sign of abating. Zinc oxide also holds at the low price level reached last year and apparently there is no chance for any nearby price improvement. Quicksilver is another item which has been under pressure, with imported material offering keen competition.

Naval stores have failed to improve their position and there seems to be no probability of any industry agreement which would set up a marketing plan whereby more favorable prices might be obtained through regulating the amount of stocks offered on the market and through restricting production.

Exporters of carbon black have been interested in an announcement to the effect that carbon black may be purchased by German firms either abroad or inland only with the specific authorization of the Trade Control Board. Furthermore, carbon black may be imported into the country only against presentation of an official purchase permit. Processing and consumption of carbon black only by written authorization and quotas will be established for each quarter based on a percentage of the average consumption of each consuming plant in 1935. In 1935 Germany imported 11,162 metric tons of black.

Among recent important price changes was the announcement by the Chilean Nitrate Sales Corp. of a decline of 24c. a lb. in the quotation for iodine. Effective May 1, the price for the Chilean product has been 90c. a lb. The reasons given for the decline were that different industries had been showing greater interest in iodine and it was thought that lower prices would make this halogen available for use in the dye industry and kindred lines.

The Hercules Powder Co., also announced at the end of the month that its enlarged ethyl cellulose plant had been completed and with larger volume of production, the company has cut the contract price to $1.35-$1.40 a lb. and single shipments to $1.42-$1.50, the range in each case depending on quantity.

China's production and distribution of vegetable oils, including tung and perilla, was placed under government control by an executive decree issued May 12, according to a report to the Department of Commerce from Commercial Attache Julean Arnold, Shanghai.

The decree provides for establishment of a semi-official corporation, capitalized at 2,000,000 yuan (approximately $740,000), to be known as the China Vegetable Oil Refinery, Ltd., which will function as agent for China's vegetable oil industry, with the view to standardizing and improving production, and will have complete control over processing and storing tung, perilla and other vegetable oils.

The corporation will also arrange financing, transportation and marketing facilities for the vegetable oil industry and is authorized to manufacture lubricating oils, paints and varnishes. Headquarters of the corporation will be located at Shanghai and eight branch plants will be established in various producing districts.

In the last year or more, there has been a marked rise in domestic consumption of oiticica oil and for 1935 a consumption of 1,828,000 lb. of babassu oil was reported in the oleomargarine trade. A new nut now being grown in the Hawaiian Islands may later assume importance not only as a food nut but also because of its oil-producing possibilities. The nut is the macadamia which is said to have a high oil content and produce an edible oil of distinctive flavor. Its commercialization is being arranged by a company with headquarters in Honolulu.

According to a report sent from Copenhagen to the Department of Commerce another barter arrangement is being negotiated. It involves the construction of three large merchant vessels in Denmark for a Chilean shipping company. The amount at issue is placed at about eleven million crowns which is to be paid for in nitrate of soda. Annual imports of nitrate into Denmark run around 38,000 tons whereas the money representing the cost of the vessels would purchase close to 70,000 tons of nitrate.

Effective immediately, a drastic Treasury Department order makes sweeping changes in the current formulas for denaturing alcohol. Formulas 5-A and 10 have been modified by the addition of two parts of hexone—methyl isobutyl ketone—to each 100 parts of ethyl alcohol. In another order, issued at the same time, the Treasury alters the specially denatured alcohol formulas 25 and 25-A, containing iodine. The new order conforms to the classification in the revised U.S. Pharmacopoeia.

The new rule directs the adding of 1.75 gallons of hexone to each 100 gallons of all stocks of completely denatured alcohol, and applies to all alcohol "on the premises, in the possession of or under the control of denaturers, including stocks sold on consignment, or remaining in the hands of denaturers or their consignees."

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**86.24**
Last month	86.38
June, 1935	87.45
June, 1934	88.35

Acetone was further reduced during the month and solvents in general were weak. Sulphate of ammonia for nearby delivery was lower with a moderate decline in the weighted index number.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**80.46**
Last month	82.13
June, 1935	92.90
June, 1934	57.48

The downward trend to prices for oils and fats continued with lowered values for linseed, coconut, corn, peanut, menhaden, red, and oleo oils. Tallow also sold at lower figures.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to June 13.

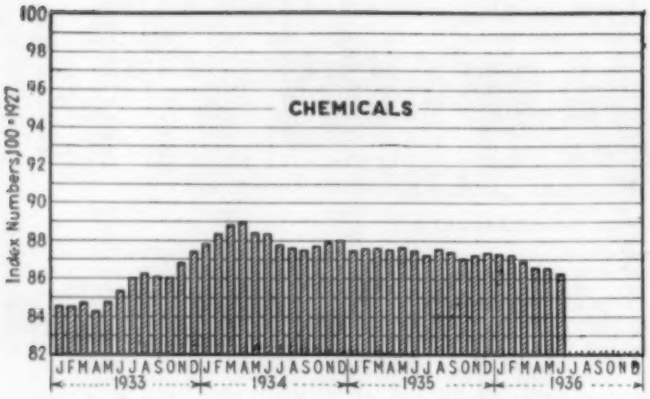
Industrial Chemicals

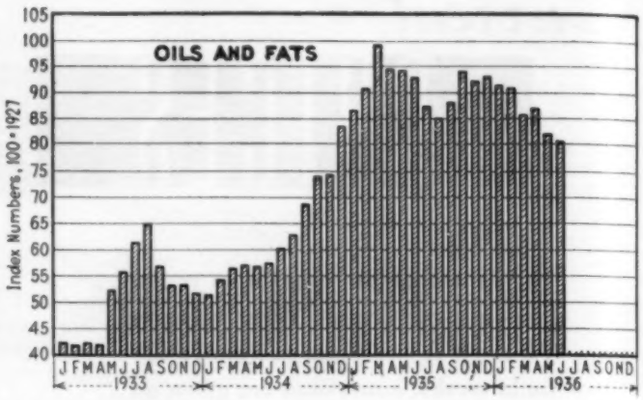
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.08½–$0.09	$0.09½–$0.10	$0.12 –$0.12½
Acid, acetic, 28%, bbl., cwt.	2.45 – 2.70	2.45 – 2.70	2.45 – 2.70
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.52 –10.77	10.52 –10.77	10.52 –10.77
Boric, bbl., ton	105.00–115.00	105.00–115.00	95.00 –105.00
Citric, kegs, lb.	.27 – .30	.27 – .30	.28 – .31
Formic, bbl., ton	.11 – .11½	.11 – .11½	.11 – .11½
Gallic, tech., bbl., lb.	.60 – .65	.60 – .65	.60 – .65
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.11½– .12	.11½– .12	.12 – .12½
22%, tech., light, bbl., lb.	.06½– .07	.06½– .07	.06½– .07
Muriatic, 18°, tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –	18.50 –20.00
Oxalic, crystals, bbl., lb.	.11½– .12½	.11½– .12½	.11½– .12½
Phosphoric, tech., c'bys., lb.	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –	15.50 –	15.50 –
Tannic, tech., bbl., lb.	.23 – .35	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb.	.24 – .25	.24 – .25	.24 – .25
Tungstic, bbl., lb.	1.50 – 1.60	1.50 – 1.60	1.50 – 1.60
Alcohol, Amyl	–	–	–
From Pentane, tanks, lb.	14.3 –	14.3–	.15 –
Alcohol, Butyl, tanks, lb.	.08½–	.08½–	.13 –
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.27½–	4.27½–	4.27½–
Denatured, 190 proof			
No. 1 special, dr., gal.	.34 –	.34 –	.36 –
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03½– .04	.03 – .04	.03 – .04
Aluminum sulphate, com., bags cwt.	1.35 – 1.50	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt.	2.00 – 2.25	2.00 – 2.25	1.90 – 2.00
Aqua ammonia, 26°, drums, lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02½	.02½– .02½	.02½– .02½
Ammonia, anhydrous, cyl., lb.	.15½– .16	.15½– .16	.15½– .16
tanks, lb.	.04½–	.04½–	.04½–
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt.	1.20 –	1.20 –	1.20 –
Amylacetate tech., tanks, lb.	.12 – .135	.12 – .135	.142–
Antimony Oxide, bbl., lb.	.13½– .14	.13½– .14	.11½– .12
Arsenic, white, p'wd., bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	72.00 –74.00	72.00 –74.00	72.00 –74.00
Nitrate, cask, lb.	.08½– .09	.08½– .09	.08½– .09
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	1.90 – 2.00
Borax, gran., bags, ton	44.00 –49.00	44.00 –49.00	40.00 –45.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.10 –	2.10 –	2.10 –
Arsenate, dr., lb.	.06 – .07	.06 – .07	.06 – .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	20.00 –33.00	20.00 –33.00	20.00 –33.00
flake, dr., del., ton	22.00 –35.00	22.00 –35.00	22.00 –35.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05½– .06	.05½– .06	.05½– .06
Tetrachloride drums, lb.	.05½– .08½	.05½– .06	.05½– .06
Chlorine, liquid, tanks, wks., lb.	2.15 –	2.15 –	2.00–
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.41 – 1.51	1.41 – 1.51	1.25 – 1.35
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	14.00 –15.00
Copper carbonate, bbl., lb.	.08½– .16	.08½– .16	.08½– .16
Cyanide, tech., bbl., lb.	.37 – .38	.37 – .38	.37 – .38
Sulphate, bbl., cwt.	4.00 – 4.25	4.00 – 4.25	3.85 – 4.00
Cream of tartar, bbl., lb.	.16½– .17	.16½– .17	.16½– .17
Diethylene glycol, dr., lb.	.16½– .20½	.16½– .20½	.16½– .20½
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	2.10 – 2.15
Imp., tech., bags, cwt.	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Ethyl acetate, drums, lb.	.07 –	.07 –	.08½–
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., contact, lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt.	.85 – 1.00	.85 – 1.00	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.14½– .15	.14½ – .15	.14 – .14½
Lead:			
White, basic carbonate, dry casks, lb.	.06½–	.06½–	.06½–
White, basic sulphate, sck., lb.	.06 –	.06 –	.06 –
Red, dry, sck., lb.	.07 –	.07 –	.06½–
Lead acetate, white crys., bbl., lb.	.10½– .11	.10½– .11	.10 – .11
Lead arsenate, powd., bbl., lb.	.09 – .10	.09 – .10	.09 – .10
Lime, chem., bulk, ton	8.50 –	8.50 –	8.50 –
Litharge, pwd., csk., lb.	.06 –	.06 –	.05½–
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal.	.33 –	.33 –	.33 –
97%, tanks, gal.	.34 –	.34 –	.34 –
Synthetic, tanks, gal.	.35½–	.35½–	.35½–
Nickel salt, double, bbl., lb.	.13 – .13½	.13 – .13½	.12½– .13
Orange mineral, csk., lb.	.10 –	.10 –	.09½–
Phosphorus, red, cases, lb.	.44 – .45	.44 – .45	.44 – .45
Yellow, cases, lb.	.28 – .32	.28 – .32	.28 – .32
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.07½– .08½
Carbonate, 80-85%, calc. csk., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Chlorate, powd., lb.	.08 – .08½	.08 – .08½	.08½– .09
Hydroxide(c'stic potash) dr., lb.	.06½– .06½	.06½– .06½	.06½– .06½
Muriate, 80% bgs., ton	23.00 –	23.00 –	22.00 –
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb.	.18 – .19	.18 – .19	.18 – .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 –	1.23 –	1.23 –
Dense, bags, cwt.	1.25 –	1.25 –	1.25 –
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.05½– .06½
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	14.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Chlorate, kegs, lb.	.06½– .06½	.06½– .06½	.06½– .06½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., lb.	2.40 – 2.50	2.40 – 2.50	2.40 2.50
Metasilicate, bbl., cwt.	2.90 – 3.00	2.90 – 3.00	3.25 – 3.40
Nitrate, bags, cwt.	1.325 –	1.325 –	1.275–
Nitrite, casks, lb.	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.022– .023	.022– .023	.022– .024
Prussiate, yel. drums, lb.	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60-62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.02½– .02½	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton	18.00 –	18.00 –	18.00 –
Chloride, dr., lb.	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl, lb.	.06½– .08	.06½– .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.50 –	.51 –	.54 –
Crystals, bbl., lb.	.34½–	.36 – .38½	.38 –
Zinc chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05½– .06
Carbonate, bbl., lb.	.09 – .11	.09 – .11	.09 – .11
Cyanide, dr., lb.	.36 – .38	.36 – .38	.36 – .38
Dust, bbl., lb.	.069– .07	.069– .07	.059– .07
Zinc oxide, lead free, bag, lb.	.05 –	.05 –	.05½–
5% lead sulphate, bags, lb.	.04½–	.04½–	.05½–
Sulphate, bbl., cwt.	2.65 – 3.00	2.65 – 3.00	2.75 – 3.00

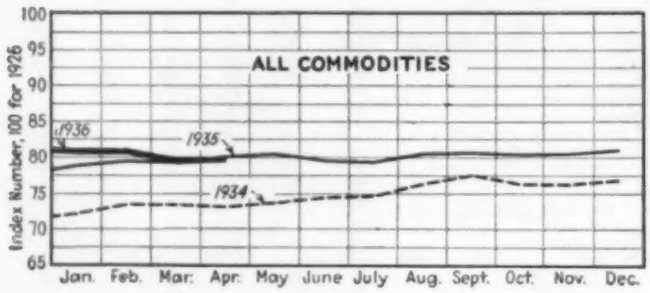
Oils and Fats

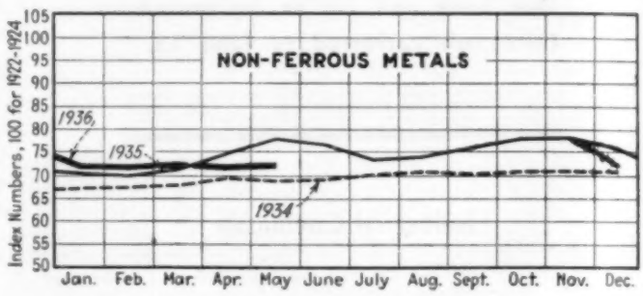
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10 –$0.11	$0.10 –$0.11	$0.09½–$0.10
Chinawood oil, bbl., lb.	.18½–	.18½–	.18–
Coconut oil, Ceylon, tanks, N. Y. lb.	.04 –	.04 –	.04½–
Corn oil crude, tanks, (f.o.b mill), lb.	.08 –	.08½–	.08½–
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.07½–	.07½–	.09 –
Linseed oil, raw car lots, bbl., lb.	.094–	.094–	.097–
Palm, casks, lb.	.04½–	.04½–	.04½–
Palm kernel, bbl., lb.	.05½–	.05½–	.05½–
Peanut oil, crude, tanks (mill), lb.	.08 –	.07½–	.09½–
Rapeseed oil, refined, bbl., gal.	.51 –	.52 –	.45 –
Soya bean, tank, lb.	.06 –	.07½–	.09
Sulphur (olive foots), bbl., lb.	.08 –	.08 –	.08½–
Cod, Newfoundland, bbl., gal.	.40 –	.40 –	.33 –
Menhaden, light pressed, bbl., lb	.06 –	.062–	.067–
Crude, tanks (f.o.b. factory), gal.	.32 –	.34 –	.30 –
Grease, yellow, loose, lb.	.03½–	.03½–	.06½–
Oleo stearine, lb.	.07 –	.07½–	.09½–
Red oil, distilled, d.p. bbl., lb.	.08½–	.09½–	.09½–
Tallow, extra, loose, lb.	.04½–	.04½–	.07½–

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1.25
Benzidine base, bbl., lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs., lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.18 – .20	.18 – .20	.15 – .16
Beta-naphthol, tech., drums, lb.	.24 – .27	.24 – .27	.22 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.11 – .11½	.11 – .11½
Cresylic acid, 99%, dr., wks., gal.	.63 – .67	.58 – .60	.42 – .43
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl., lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil, 25%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.07 – .07½	.07 – .07½	.05½– .06
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	1.10 – 1.15	1.10 – 1.15	1.10 – 1.15
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.40 – .42
Solvent naphtha, w.w., tanks, gal.	.26 –	.26 –	.26 –
Toludine, bbl., lb.	.88 – .90	.88 – .90	.88 – .90
Toluene, tanks, works, gal.	.30 –	.30 –	.30 –
Xylene, com., tanks, gal.	.30 –	.30 –	30 –

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grid., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.15 – .17	.14½– .16	.12 – .13
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 – .20	.04 – .20	.04 – .20
Prussian blue, bbl., lb.	.37 – .38	.37 – .38	.36½– .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.26 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.80 – .85	.80 – .85	.80 – .85
Vermilion, English, bbl., lb.	1.59 – 1.60	1.59 – 1.60	1.52 – 1.56
Chrome yellow, C. P., bbl., lb.	.12 – .14	.12 – .14	.15 – .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.09 – .10	.09 – .10	.09 – .10
Manila, bags, lb.	.09 – .10	.09 – .10	.16 – .17
Damar, Batavia, cases, lb.	.13½ .16	.15½– .16	.15½– .16
Kauri No. 1 cases, lb.	19 – .25	.20 – .25	.20 – .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	50.00 –	50.00 –	50.00 –
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	5.65 –	5.50 –	5.65 –
Turpentine, gal.	.41 –	.42 –	.50½–
Shellac, orange, fine, bags, lb.	.25 –	.25 –	.25 –
Bleached, bonedry, bags, lb.	.19 –	.19 –	.21 –
T. N. bags, lb.	.14½–	.14½–	.14 –
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
325 mesh (f.o.b. N. Y.), ton.	13.75 –	13.75 –	13.75 –

INDUSTRIAL NOTES

General Refractories Co., Philadelphia, has appointed E. Carey & Co., Portland, Me., as dealer agent in the Maine territory.

The Fort Washington Chemical Co., Philadelphia and Fort Washington, Pa., has been granted a charter by the State of Pennsylvania. The company will manufacture litharge, sodium nitrite, arsenate of lead, etc. Alex C. Ferguson Co. of Philadelphia will act as distributors.

Foster Wheeler Corp., New York and General Regulator Corp. have consolidated the sales departments of the two companies with headquarters at 165 Broadway, New York.

New Departure Mfg. Co., Bristol, Conn., has moved its sales engineering office in Chicago to 230 North Michigan Ave.

American Engineering Co., in new quarters at 75 West St., New York, has placed John F. Cooke in charge of sales in the hoist, pump and marine division.

Claude B. Schneible Co., Chicago, has added as sales representatives, Parry Engineering Co., New York, Ferdinand G. Schultz, Pittsburgh, Grant & Co., Los Angeles, Pacific Graphite Works, Oakland, and Carl F. Miller & Co., Spokane.

Glyco Products Co., Inc., New York, has moved its offices, laboratory, and factory to 148 Lafayette St.

Egyptian Lacquer Mfg. Co., New York, has moved its offices to the R.K.O. Building, 1270 Sixth Ave.

Republic Steel Corp., Cleveland, has appointed L. L. Caskey district sales manager in the Philadelphia territory. J. B. De Wolfe whom Mr. Caskey succeeds has been transferred to the Cleveland office.

Chicago Pneumatic Tool Co., New York has opened a new sales and service branch at 2415 Commerce St., Dallas, Texas.

Morris Machine Works, Baldwinsville, N. Y., has elected Carl Lager, president to succeed the late Windsor Morris. Pierce J. McAuliffe has been elected vice-president and general manager.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$77,000	$177,000	$426,000	$381,000
Middle Atlantic	1,470,000	373,000	4,302,000	7,757,000
South	.....	.....	1,227,000	5,738,000
Middle West	270,000	327,000	4,159,000	5,168,000
West of Mississippi	300,000	.....	5,808,000	5,963,000
Far West	3,000,000	1,280,000	3,543,000	4,782,000
Canada	.....	2,060,000	12,168,000	8,037,000
Total	$5,117,000	$4,217,000	$31,633,000	$37,826,000

PROPOSED WORK
BIDS ASKED

Cement Plant—Universal Atlas Cement Co., 208 South La Salle St., Chicago, Ill., will construct a cement plant at Hudson, N. Y., to include grinding buildings, crusher house, storage building, etc. Owner will soon take bids on general contract exclusive of steel. A. Carlson, c/o Owner, Engr. Estimated cost $1,000,000.

Chemical Plant—Royal Manufacturing Co., Duquesne, Pa., will soon receive bids for the construction of a 3 story, 50x120 ft. factory at 22 North First St., Pittsburgh Contracting & Engineering Co., 811 Rebecca St., Wilkinsburg, Pa., Archt. Estimated cost $40,000.

Distillery—Meadville Pennsylvania Distillery Co., Inc., T. Kratz, Supt., Meadville, Pa., is having plans prepared by F. F. Bollinger Co., Engr., Ambridge, Pa., for rehabilitating distillery to include grain elevator, bottling house and warehouse. Estimated cost $300,000.

Factory—Climax Molybdenum Co., Woodrow Wilson Ave., Detroit, Mich., plans to construct a 60x200 ft. factory. C. W. Dichey, 2225 David Stott Bldg., Detroit, Archt. Estimated cost $40,000.

Factory—C. W. Haynes Laboratories, Inc., E. F. Bassette, Pres., Hampden St., Springfield, Mass., manufacturers of lacquers, plans to construct a factory. Estimated cost will exceed $37,000. Maturity indefinite.

Factory—Linde Air Products Co., 30 East 42nd St., New York, N. Y., is having plans prepared for the construction of a branch factory at Essington, Pa. Estimated cost may exceed $100,000.

Fertilizer Plant—Olds & Whipple, Inc., 166 State St., Hartford, Conn., will soon award the contract for the construction of a 1 story, 130x145 ft. plant addition. Estimated cost $40,000.

Glass Factory—Fairmount Glass Works, J. H. Rau, Jr., Mgr., Belt Ry. and South Keystone Ave., Indianapolis, Ind., will soon award the contract for an addition to its glass jar manufacturing plant. D. A. Bohlen & Son, 1001 Majestic Bldg., Indianapolis, Archt. Estimated cost $80,000.

Glass Factory—Owens-Illinois Pacific Coast Co., 85 Second St., San Francisco, Calif., plans to construct a factory at Alameda and Fruitvale Aves., Oakland, Calif. Bids are now being received by P. J. Walker Co., Mgrs. of Construction, Sharon Bldg., San Francisco. Estimated cost will exceed $1,000,000.

Pulp Plant — Soundview Pulp Co., Everett, Wash., plans to construct an addition to its pulp plant provided the city will furnish them 12,000,000 gal. of water and an option on 12,000,000 additional gallons. Estimated cost $2,000,000.

Refinery — Mid Continent Petroleum Corp., 1128 West Main St., Oklahoma City, Okla., plans to construct a gasoline refinery near Holdenville, Okla. Estimated cost $100,000.

Refinery — Phillips Petroleum Co., Bartlesville, Okla., has had plans prepared by A. H. Rinery, Engr., Bartlesville, for the construction of a casinghead gasoline plant at 28th and Prospect Sts., Oklahoma City, Okla. Estimated cost $200,000.

Research Laboratory—General Motors Corp., General Motors Bldg., Detroit, Mich., is having plans prepared by Albert Kahn, Inc., Archt., New Center Bldg., Detroit, for the construction of a research laboratory on Milwaukee Ave. Estimated cost $150,000.

CONTRACTS AWARDED

Chemical Factory — Harshaw Chemical Co., 1945 East 97th St., Cleveland, O., has awarded the contract for an addition to its factory, also crane runway, at 1000 Newburgh Ave., to M. Swisher, 1718 Lakefront Ave., Cleveland. Estimated cost $30,000.

Factory—Aluminum Company of America, J. Dearsbaugh, Construction Engr., 2600 Harvard Ave., Cleveland, O., has awarded the contract for steel work for factory to Ft. Pitt Bridge Works, Massillon, O. Owner will do brick work. Estimated cost $30,000.

Factory — Colgate-Palmolive-Peet Co., Green St. near York St., Jersey City, N. J., has awarded the contract for the construction of an 8 story factory to Turner Construction Co., 420 Lexington Ave., New York, N. Y. $185,000.

Factory—Standard Fuel Engineering Co., 667-687 Post Ave., S., Detroit, Mich., is building a new addition to its factory which will increase the floor space one third and permit a complete revamping of machinery for doubling the capacity of the plant. The increasing demands for Zero refractory products and standard industrial furnaces have necessitated the expansion.

Fertilizer Factory—Swift & Co., Union Stock Yards, Chicago, Ill., has awarded the contract for a 1 story, 100x150 ft. addition to its fertilizer factory on South Muskegon St., Milwaukee, to Hunzinger Construction Co., 1827 North 27th St., Milwaukee, Wis.

Ore Flotation Mill—Mountain City Copper Co., Mountain City, Nev., will construct an ore flotation mill to have a capacity of 300 tons. Work will be done by separate contracts. Estimated cost $50,000.

Laboratory — Eastman Kodak Co., Kodak Park, Rochester, N. Y., has awarded the contract for the construction of a 6 story, 62x140 ft. research laboratory to Ridge Construction Corp., Kodak Park, Rochester.

Drug Factory — United Drug Co., Ltd., 68 Broadview St., Toronto, Ont., Can., has awarded the general contract for an addition to its factory to Walter Davidson & Co., Ltd., 188 Duke St., Toronto. Estimated cost $60,000.

Gas Products Factory—Butler Gas Products Corp., A. H. Steinbrecher in charge, 40th St., Pittsburgh, Pa., has awarded the contract for the construction of a 2 story, 50x100 ft. factory to The Austin Co., Union Trust Bldg., Pittsburgh.

Gas Metering Factory—Michigan Gas Transmission Co., River Rouge, Mich., has awarded the contract for the construction of a gas metering factory for natural gas transmission plant to Hazleton & Clark, 1038 Michigan Theatre Bldg., Detroit. Estimated cost $50,000.

Laboratory—Hartford Gas Co., 233 Pearl St., Hartford, Conn., has awarded the general contract for alterations and extensions to its laboratory, storage unit and office building to Bartlett-Brainard Co., 16 Van Dyke Ave., Hartford. Estimated cost $37,000.

Lime Plant—Belle Isle Lime Co., St. Jean and Belt Line R.R., Detroit, Mich., has awarded the contract for the construction of a plant for the production of high calcium lime, to Bennage & McKinstry, 4612 Woodward St., Detroit. Estimated cost $50,000.

Paper Factory—Crown Willamette Paper Co., Camas, Wash., has awarded the contract for an addition to its factory to Austin Co., Dexter Horton Bldg., Seattle. Estimated cost $80,000.

Paper Factory—Thilimony Pulp & Paper Co., Kaukauna, Wis., has awarded the contract for an addition to its factory for beater room and bleach plant to Permanent Construction Co., 2712 North Holton St., Milwaukee. Estimated cost $40,000.

Pulp Plant—St. Regis Kraft Co., 235 Park Ave., New York, N. Y., will remodel and enlarge pulp plant at Tacoma, Wash., idle since 1930, and convert same into plant for production of bleached pulp. Work will be done by day labor. S. H. Ferguson & Co., 200 Fifth Ave., New York, Consult. Engrs. Estimated cost $1,000,000.

Refinery—Conewango Refining Co., T. Moore, Purchasing Agt., Market St., Warren, Pa., has awarded separate contracts for the construction of a barrel house at its crude oil refinery. Estimated cost $40,000.

Refinery — Quaker State Oil Refining Co., Chambers Bldg., Oil City, Pa., has awarded the contract for alterations, additions and repairs to McKean Refinery at Farmers Valley, Pa., to include new dewaxing plant and equipment, to E. B. Badger Sons Co., 271 Madison Ave., New York, N. Y.

Regulator Building — Detroit City Gas Co., Clifford St., Detroit, Mich., has awarded the contract for the construction of a regulator building to Hazleton & Clark, 1038 Michigan Theatre Bldg., Detroit. Estimated cost $40,000.

Soap Factory—Ponds Extract Co., Clinton, Conn., has awarded the contract for the construction of a factory for the manufacture of soap, cold cream, etc., to Aberthaw Construction Co., 80 Federal St., Boston, Mass. Estimated cost $140,000.

Sulphur Recovery Plant—American Smelting & Refining Co., 120 Bway., New York, N. Y., will construct a sulphur recovery plant at Garfield, Utah. Work will be done by day labor and separate contracts. Estimated cost will exceed $150,000.

Warehouse — United Color & Pigment Co., 432 West 45th St., New York, N. Y., has awarded the contract for the construction of a 2 story, 80x120 ft. warehouse on Evergreen Ave., Newark, N. J., to J. Muscarelle, 20 Harrison Ave., Garfield.

Newsprint Machines—Ontario Paper Co., 485 McGill St., Montreal, Que., Can., has awarded the contract for two 262 in. newsprint machines for paper mill at Comeau Bay, Que., to Dominion Engineering Co., Ltd., First Ave., Lachine, Montreal. Estimated cost $2,000,000.

Larger Movement of Chemicals Into World Export Trade Last Year

By C. C. CONCANNON and A. H. SWIFT
Chemical Division, U. S. Bureau of Foreign and Domestic Commerce

A DIRECT result of the large number of factories opened or capacity of existing plants expanded during the past two years was a greater demand for many industrial chemicals and chemical materials with increase in foreign chemical trade in the last two years. An indirect result coupled with the progress evident in many countries was the call for chemical products of higher quality and larger imports of those which included paints, lacquers, and varnishes, medicinals and toilet preparations.

With the possible exception of France, all major producing countries recorded expansion in chemical export trade in 1935. Preliminary official statistics for the first ten months of 1935 show that exports of chemicals and allied products from France declined 4 per cent but this loss is so small that if exports were greater in the last two months as was probably the case, they may have more than offset the reduction.

In 1934, eight countries, Germany, United States, United Kingdom, France, Belgium, Netherlands, Switzerland and Japan accounted for 74 per cent of the world's exports of chemicals and allied products and 47 per cent of the imports.

In 1934, total world exports of chemicals and allied products exceeded $1,063,411,000 and imports, $1,178,112,000, according to statistics compiled from official reports published by each foreign country.

World Export and Import Trade in Chemicals and Related Products in 1934

(In Thousands of United States Dollars)

	Exports	Imports	Leading Commodities Exported
Europe	752,430	653,302	
Austria[1]	5,722	13,600	Miscellaneous
Belgium[1]	57,696	45,922	Basic slag, fertilizers, industrials, misc.
Bulgaria	256	2,454	Rose oil
Czechoslovakia	9,900	17,700	Dyes, naphthalene, misc.
Denmark	3,215	20,930	Casein, superphosphates, rennet
Estonia[1]	431	2,101	Plastics, casein, matches
Finland[1]	731	11,418	Naval stores, chlorates, matches
France[1]	111,894	76,406	Perfumery and materials, naval stores, misc.
Germany[1]	251,500	100,500	Dyes, potash, medicinals, industrials, misc.
Greece[1]	2,571	6,629	Naval stores, tartrates
Hungary	3,568	10,386	Medicinals, alcohol, nitrogenous fertilizers
Irish Free State	190	8,432	Disinfectants, glue
Italy[1]	23,700	40,700	Sulphur, citrus oils and by-products, tartrates, misc.
Latvia[1]	172	3,134	Glue, red lead, alkalis
Lithuania[1]	140	1,489	Superphosphates
Malta	5	536	
Netherlands[1]	46,000	55,000	Pigments, coal-tar derivatives, quinine, am. sulphate
Norway	21,133	10,163	Nitrate, electrochemicals, pyrites, explosives
Poland and Danzig[3]	5,200	9,900	Fertilizers
Portugal[3]	2,429	5,849	Naval stores, pyrites, tartrates
Rumania[1]	1,689	11,483	Acetone, alcohol, ess. oils, misc.
Soviet Russia	20,225	14,325	Apatites, basic slag, potash, am. sulphate, misc.
Spain[1]	8,100	16,000	Potash, pyrites, naval stores
Sweden	9,808	31,313	Matches, superphosphates, carbide, dynamite, misc.
Switzerland	40,400	26,400	Dyes, medicinals, electrochemicals
Albania	5	180	
United Kingdom	123,400	105,052	Alkalis, insecticides, coal-tar oils, am. sulphate, med., paints
Yugoslavia	2,350	5,300	Pyrethrum, misc.
North and Central America	151,612	157,491	
Canada	15,300	34,500	Cyanamide, acetic acid, sodium cyanide
British Honduras	.....	162	
Costa Rica	.....	314	
Guatemala	10	700	Ess. oils, beeswax
Honduras[4]	16	735	Botanicals
Nicaragua	34	428	Balsams
Panama	.....	1,100	
Salvador[4]	52	433	
Mexico[1]	1,100	10,000	Naval stores, lime oil, candelilla wax
Newfoundland	500	800	Cod oil, guano
British West Indies	873	3,656	
Jamaica	511	997	Citrus oils, logwood extract, beeswax
Trinidad & Tobago	60	640	Lime oil
Windward Islands	.....	178	
Leeward Islands	292	123	Lime oil, orange oil, bay rum
Cuba	355	5,308	Beeswax, alcohol, glycerine
Dominican Republic	49	693	Beeswax, resin
Netherland West Indies	556	497	Phosphate, aloes
Martinique	3	1,180	Lemon oil
Haiti	170	566	Logwood, neroli oil
United States, including Alaska, Hawaii, Puerto Rico	132,594	96,509	Sulphur, alkalis, naval stores, phosphate, medicines, paints

	Exports	Imports	Leading Commodities Exported
South America	26,685	57,462	
Argentina	4,350	16,900	Casein, animal byproducts
Bolivia[4]	330	764	Gums, cinchona
Brazil	5,400	22,400	Carnauba wax, copaiba and rosewood oils, botanicals
Chile	15,704	2,400	Nitrates, iodine, guano
Colombia[4]	76	4,700	
Ecuador[4]	25	1,400	Cascarilla bark, drugs
British Guiana	.....	888	
Surinam	.....	75	
Paraguay[4]	129	215	Oil of petitgrain
Peru	372	3,259	Cube root, guano
Uruguay	263	1,536	Guano, casein, animal byproducts
Venezuela	36	2,925	
Asia	95,903	196,428	
British India	17,736	44,084[4]	Lac, ess. oils, pot. nitrate, misc.
Br. Malaya	7,123	12,149	Gums, natural products
Ceylon	711	4,042	Ess. oils, papain
China	16,328	33,700	Tung oil
Netherland India	8,030	17,666	Cinchona bark, gums, ess. oils
French Indo-China	1,200	4,806	Oils, lac and other gums, misc.
Hong Kong	12,013	15,187	Tung oil, am. sulphate, botanicals
Iraq	265	1,125	Licorice root
Japan	27,168	48,908	Camphor, menthol, medicinals, toiletries, industrials
Palestine	not available	1,714	Potash
Iran	1,400	965	Gums, henna, drugs
Philippine Islands	308	7,047	Gums, natural products, glycerine
Siam	500	3,100	Gums, lac
Turkey	2,829	1,351	Gums, natural products
Aden	292	584	Gums, wax
Oceania	4,448	33,744	
Australia	2,858	21,566	Eucalyptus oil, arsenic, animal dips
French Oceania	174	39	Aniseed and other ess. oils, nux vomica, botanicals
New Zealand	1,416	12,139	Kauri gum
Africa	32,333	79,685	
Anglo-Egyptian Sudan	2,525	841	Gum arabic, henna, senna, beeswax
Belgian Congo	3,063	3,700	Copal, beeswax, radium
British East Africa	1,507	2,630	Soda ash, beeswax, gums, geranium & clove oils
Union South Africa	463	18,112	Buchu leaves, aloes, pigments
Other Br. South Africa	85	4,736	Beeswax, gums
Gold Coast	20	1,578	Lime oil, copal, potash
Nigeria	49	1,369	Gum arabic, potash
Other Br. West Africa	31	103	Beeswax, copal
Egypt	2,402	17,062	Beeswax, henna, phosphate
Algeria, Tunis	10,189	19,896	Phosphate, tartrates, geranium oil, botanicals
Madagascar	516	896	Clove, ylang-ylang and ess. oils, beeswax, guano
Other French Africa	392	2,162	Ess. oils, particularly orange
Italian Africa	368	809	Gums, waxes
Morocco	10,182	3,495	Phosphates
Mozambique	46	544	Gums, waxes, ess. oils
Other Portuguese Africa	431	332	Gums, waxes
Canary Islands	58	1,244	
Other Spanish	6	176	
Total	1,063,411	1,178,112	

[1]Preliminary subject to correction; [2]incomplete figures; [3]principal commodities only; [4]a year earlier than 1934.